SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

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FRIDAY, MAY 30, 1902.

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*SCIENTIFIC RESEARCH.**

IN connection with the so-called form of initiation as prescribed by the constitution of this Society we find this precept, 'The president or his deputy shall explain the aims and objects of the society.'

I understand it to be a common interpretation of this provision that a more or less formal address is to be presented, either by the president of the chapter, or what in the present case at least would be better, by some distinguished member of the society acting as deputy, to retain the phraseology of the written law.

In connection with the exercises of this evening the duty appears to fall upon my shoulders, but it is not my purpose to make this communication either lengthy or formidable.

As to the aims and objects of this society we find them fully set forth in section 2 of the Constitution viz.:

> The object of this Society shall be to encourage original investigation in science, pure and applied: by meeting for the discussion of scientific subjects; by the publication of such scientific matter as may be deemed desirable; by establishing fraternal relations among investigators in the scientific centers and by granting the privilege of membership to such students as have, during their college course, given special promise of future achievement.

* Address delivered at the initiation of new members of the University of Pennsylvania Chapter of the Society of Sigma Xi, April 18, 1902.

It is then with science, pure and applied, that we have to deal as distinguished from those departments of study, called by their votaries the humanities. These are defined as 'the branches of polite or elegant learning, as languages, rhetoric, poetry and the ancient classics.'

Now we shall have no quarrel with these pursuits or with those devoted to them, unless it be with the assumption that they are essentially the polite and elegant branches of learning as distinguished from the pursuits of science, and that the latter must be relegated to a lower plane. We accept no second place for science either from the standpoint of its importance to the welfare of the human race, or as a means of culture in a system of education.

No doubt it would greatly benefit many or all of us if we could spare more time from our pressing duties for the enjoyment of poetry, of literature and the fine arts, but we are also persuaded that very many of those who find their vocation in these fields would find great advantages in a more intimate acquaintance with physics, chemistry and biology.

The object of our Society, as above stated, is to encourage original investigation in science, pure and applied. What then is science and what constitutes original investigation? The term science is much abused by many who appropriate it. Ever since the days of St. Paul, and doubtless for a much longer period the human race has had with it innumerable forms of science falsely so-called. It is as important to-day and for ourselves as it was for Timothy nearly 2,000 years ago, that we should avoid what Paul called the vain babblings of this description of science.

When, however, we examine critically the meaning of this term we find it to be one which may be employed to designate all departments of human knowledge. 'Scire,' to know, is the root from which it springs. We understand it to apply, however, only to such departments of knowledge as have been formulated and classified with reference to general laws, and it is the attempt to discover such laws, underlying and connecting the phenomena which we see about us that constitutes scientific investigation. Whenever all of the observed facts of any science, as astronomy or chemistry or biology, can be so fully understood as to admit of expression in a strictly mathematical form, this science may be considered complete. It is perhaps unnecessary to add that we possess no such completed science, nor is there any promise that we ever shall.

The term science then embraces a great number of departments of knowledge and deals with truth in almost every form, so soon as we have the means of assuring ourselves that foundation principles are indeed truth and not fiction. Thus we have psychology, theology, economics, sociology, mathematics, the entire range of physical and biological sciences, and many other departments of mental activity which may be regarded as possessing claims, more or less admissible, to be included within this honored body.

When we refer to the object of this Society as expressed by its founders—to encourage original investigation in science—we might perhaps infer that we were taking all knowledge as our province. This, however, is not our purpose. The science with which we are now concerned is understood to be limited to the mathematical and physical branches.

This limitation is emphasized by reference to the history of the Society. I quote from the report of a committee appointed in 1893 to consider some matters related to the policy to be pursued.

> The Society was established in 1886 by a few earnest workers in the engineering sciences, as a means of rallying and encouraging those qualities which were deemed of the first importance in their own lines of investigation. It soon became

broadened and enlarged to represent the general ideals of highest scholarship in the minds and before the ambitions of every earnest student in any branch of science. It proposed to recognize and elect to its membership those men in our institutions of learning who should exhibit in a marked degree the qualifications of natural endowment and training required for successfully conducting original research in various branches of science.

Then among the conditions which must be met in order to qualify an institution for the establishment of a Chapter we find this:

That the number of distinct branches of science represented by full professors in the institution shall be at least five; and these branches should include mathematics, physics, chemistry, biology (some department of it) and engineering (some department of it).

This Society then has for its object the encouragement of original investigation in science. But what constitutes original investigation, and how is it to be carried on? Probably all of us have known earnest students of science in some of its forms, men or women it may be who by reading and study have acquired a great fund of information, but who have no more idea of any way in which they can add anything to the existing store than has a new-born babe.

Some have regretted their misfortune in being born too late. If they could have appeared on the scene before Shakespeare had exhausted the field of dramatic literature, or Newton and Laplace that of universal gravitation, or Columbus that of geographical discovery, they could have done these things, and thereby have achieved immortal fame.

On the other hand as an illustration of the true scientific investigator let us consider the example of Mr. S. W. Burnham, of Chicago. Mr. Burnham is the leading authority of the world in the astronomy of double and multiple stars. His profession is that of a stenographer, astronomy or physics occupying no prominent place in his early training. Forty years ago, as many other men have done before and since, Mr. Burnham purchased for his entertainment and instruction a cheap telescope of five inches aperture. This was soon afterwards replaced by a slightly larger one, which in turn gave way in 1869 or thereabouts to a six-inch glass by the celebrated Alvan Clarke. This modest instrument Mr. Burnham pronounces simply perfect in performance.

The thousands of double stars which are scattered in every part of the heavens had an especial fascination for this amateur astronomer. To quote his own words:

My attention for some reason or other which I am unable to explain, had been almost exclusively directed to double stars previous to this while using the smaller telescope referred to. This preference was not in any sense a matter of judgment as to the most desirable or profitable department of astronomical work, or the result of any special deliberation upon the subject. It came about naturally without any effort or direction on my part.

A little building in the rear of Mr. Burnham's residence sheltered his telescope from the elements, and here he found his pleasure after the work of the day was over in scanning the heavens, identifying and measuring the systems which had been found by the Herschels and the Struves, and in gathering up hundreds of pairs which had been overlooked by his predecessors. During all the early years of his activity in this field, he was actuated only by the satisfaction which he was deriving and probably never suspected that it involved anything remarkable. It is hardly an exaggeration to say that he awoke one morning to find himself famous.

Contrast this brief account with the history of another aspirant for glory in this same field, Sir James South, of England.

In 1842 the late Professor O. M. Mitchel visited Europe for the purpose of inspecting foreign observatories, and purchasing a telescope for the

proposed Cincinnati Observatory. In the interest of this object he visited most of the leading European astronomers, and among others, Sir James South. This was during or about the time of a long litigation, which grew out of a contract between this astronomer and a firm of instrument makers who undertook to mount equatorially a large object-glass belonging to South. Mitchel describes his interview as follows:

One apartment was examined after another, until finally we reached a large room surmounted by a dome of great size and expensive construction, while fragments of the framework for mounting a great equatorial were scattered about. "Here," exclaimed Sir James, "you behold the wreck of all my hopes. Here I have expended thousands and flattered myself that I was soon to possess the finest instrument in Europe, but it is all over, and there's an end."

I remarked that the object-glass was still in his possession and might yet be mounted, so as to realize his hopes and expectations.

"No," said Sir James, "Struve has reaped the golden harvest among the double stars and there is little now for me to hope or expect."

It would be difficult to appreciate the feelings which at that moment were sweeping through the mind of the astronomer. Long cherished visions of fame and high distinction, or perhaps of grand discoveries in the heavens which for years had played round his hopes of the future, had fled forever. Another had reaped the golden harvest, and like Clairault who wept that there was not for him, as for Newton, the problem of the universe to solve, Sir James South could almost weep to think that another's eye had been permitted to sweep over the far distant realms of space, which he had long hoped might remain his own peculiar province.

Yet this very field which Struve was supposed to have exhausted is precisely where Burnham was winning his laurels a quarter of a century later. As to its exhaustion we have the best of authority in Burnham's own words. He says:

The late L. W. Webb, author of 'Celestial Objects for Common Telescopes,' one of the most eminent English amateur astronomers, in a letter written to me in 1873, after the publication of my first three catalogues said: "It will hardly be possible for you to go on for any great length of time as you have begun because the number of such objects is not interminable, and every fresh discovery is one less to be made." Since that time more than 1,000 new double stars have been added to my own catalogue, and the prospect of future discoveries is as promising and encouraging as when the first star was found with the six-inch telescope.

It seems strange when we think of the thousands of years during which the human race has inhabited this planet, that so long a period elapsed before anything which could properly be called scientific inquiry manifested itself.

One of the first problems to present itself was the greatest of all and may be said to include all others, viz., the problem of the universe itself; the origin, structure and end of the world on which we live and of the attendant bodies as the sun, moon and stars were supposed to be. Naturally the first attempts at solution were what may be called theological. One such with which we are all familiar forms the opening paragraph of the book of Genesis, 'In the beginning God created the heavens and the earth.' As humble inquirers after knowledge I have no doubt we may accept this account without the slightest hesitation, but this helps us very little in our quest for scientific truth. Neither the heavens nor the earth nor anything therein is the result of a supreme act of creative power exerted once and for all, but rather of an unfolding or evolution from a former condition in accordance with the unchanging laws of nature.

Suppose by the way of fixing our ideas that we were able to trace backward the history of our earth from its present status to that of a highly heated self-luminous globe, before life in any form had made its appearance, or carrying our history farther into the past to a time when this earth with the sun and all of the planets were united in a single mass of nebulous matter filling and extending far beyond the orbit of Neptune. Have we now reached

the beginning spoken of, or shall we push our investigation farther into the remote past, to account for the existence and characteristics of this nebulous matter which constitutes raw material out of which suns and worlds are formed?

After a long and active struggle which even now perhaps is hardly ended, it has come to be understood that scientific research and theological views cover entirely different ground and that any conflict between the two is purely of man's invention. It is now more than 250 years since Galileo was compelled to renounce the heretical doctrine which placed the sun and not the earth at the center of the planetary system. But little more than one tenth of that time has passed since a distinguished geologist, himself an active Methodist, is said to have been compelled to sever his connection with a so-called university for holding the view that this planet had been occupied by the human race for a longer period than 6,000 years.

It was the Greek philosophers who first attempted by reason and research to solve the physical problems with which we as a society are concerned. Many of these were men of remarkably keen intelligence and the measure of their success marked the highest level reached in these directions for 1,500 years or more. Until the somewhat indefinite period known as the renaissance, almost the only science known, at least in Europe, was that of the Greeks. No one can deny that humanity is deeply indebted to them for this heritage. Regarded however as a solution of the problem in view, the efforts of the Greek philosophers were one and all a sad failure. Their effort was nothing less than to find an answer to that ancient and insoluble riddle, the problem of the universe; their method, the utterly fruitless one for this purpose, that of deduction. They hoped to find a great, general, all-embracing principle, and by pure reason to evolve from it everything which exists. Thus Thalis regarded water as the origin of all things, another ascribes this place of honor to air, and another to fire. It is true that Aristotle and others insist upon the importance of observing and classifying the facts of nature, and studying in this way the fundamental laws connecting and governing them, but how effectually or ineffectually this was done may be shown by one simple example, viz., the law of falling bodies as enunciated by Aristotle himself. This he states to be that bodies descend more quickly in proportion as they are heavier. It seems almost incredible that a statement, the falsity of which is so easily proved, should have been made by Aristotle in the first place, and in the second place should have been accepted apparently without question for 2,000 years. I know of no example drawn from the history of science which impresses me more forcibly with the propensity of the average human being persistently to close his eyes to those things going on around him, and to refer to the authority of another for an account of that which it would seem he could hardly avoid seeing for himself. In the present case it was only necessary to drop two stones of unequal weight from a house top to prove the statement erroneous, but if any one took upon himself the small amount of trouble this implied, before Galileo utilized for the purpose the leaning tower of Pisa, history is silent on the subject.

Perhaps the most ambitious attempt ever made towards evolving a universal science was that of Descartes. This philosopher boldly asserted that he should consider it of small importance to show how the universe is constructed, unless he could show that it could not have been constructed in any other way. His method was that which had been so often tried and found wanting as an instrument for the study of nature—

that of deduction. Time is wanting for an examination of the details of this ambitious scheme, nor is it necessary to say that in its main purpose it proved a lamentable failure. Nevertheless the Cartesian philosophy enjoyed great popularity on the continent of Europe for many years, where it blocked the way to the acceptance of the true doctrine of gravity as developed by Newton. It is a disputed point whether this system was more of a help or a hindrance in furthering the cause of truth.

It seems a little strange perhaps that a mind so acute as that of Descartes, whose possessor made such important contributions to pure mathematics, should not have perceived, as did his contemporary, Bacon, that the truths of nature can only be learned by the study of nature, by a patient and careful attention to details, discarding at once the notion that our feeble powers can by any possibility attain to a comprehension of the entire scheme of the universe.

As an illustration of the process by which the sciences having to do with the material things of nature are developed let me invite your attention to that one with which I am more familiar than with any other, astronomy.

There is no people or tribe so rude or so low in the scale of intelligence as not to be familiar with some of the fundamental truths of astronomy. In fact we may almost say that the lower animals possess some astronomical knowledge. But a familiarity with the diurnal and annual motions of the sun, the changes of the moon, and even the ability to recognize at sight every star visible to the eye, to assign its proper place in the constellation to which it belongs and to tell at what season of the year it is visible, all this comes far short of constituting a science of astronomy. These phenomena and many others had occupied the attention of the Chaldeans and Egyptians for hundreds of years, but these people never had anything which could properly be called a science of astronomy. Nevertheless the records of eclipses and other phenomena preserved by these students of the heavens were of very great service to the true founder of the science, Hipparchus, about 150 B.C. The first step toward the founding of any science is the same in character. A working hypothesis must be devised which will connect together in the best manner possible the detached facts of observation. It is here that a judicious use of the scientific imagination is called for.

If the choice of a hypothesis is a happy one it may prove to be the first approximation to the true law of which we are in search. It is to be adhered to so long as we can represent by it in a satisfactory manner all of the facts of observation, and the moment when it is found to conflict with observation it must be modified or abandoned. The investigator who sets himself to work looking for facts to sustain a favorite theory is pretty likely to succeed to his own satisfaction, but he is not the man who contributes greatly towards increasing the world's store of scientific knowledge.

But to return to Hipparchus. His system is well known. The earth was the center of the universe; the mechanism of the celestial motions was a combination of circles; by properly proportioning the parts of the machine the celestial motions could be represented with as high a degree of accuracy as they could be observed with the primitive instruments of those days. Eclipses and other celestial phenomena could be predicted, and the thoroughness with which the work was done is attested by the fact that this system answered all requirements for a period of more than 1,500 years. Yet we know that what we may call the two fundamental hypotheses

of Hipparchus were erroneous—placing the earth at the center, and assuming the motions to be uniform and circular. As to the first of these we must admit that with the evidence then attainable it was the most plausible. In fact as regards the stars we are now, or were until quite recent times, in very much the condition which confronted Hipparchus in considering the earth and sun. We know that many of the stars have proper motions, as they are called. In reference to any individual star the appearance would be the same whether we ascribed this motion to the star itself or to our system. The true condition of things is one of the problems which is engaging the attention of the astronomers of to-day.

As to the attempt to represent the planetary motions by combinations of circles, this is precisely what we are constantly doing when we expand the expressions entering into our planetary theories in terms of sines and cosines.

A time came when the primitive system of Hipparchus could no longer be made to harmonize with the results of observation. It was therefore destined to give way to another which may be considered as a second approximation—that of Copernicus, as perfected by the labors of Kepler. Here the sun is the center of planetary motion; the orbits are ellipses with the sun in one of the foci, but the fundamental cause of these motions, the law of gravity, and the modifications produced by the mutual perturbations are as yet unrecognized. No place is found for those apparently erratic bodies called comets.

The next great advance is due to the labors of Newton; by referring all to the law of universal gravitation he was able to explain not only the elliptic motions, but the departures from these curves produced by the mutual perturbations of the planets. At the same time it was shown that the comets which heretofore had been regarded with suspicion as erratic visitors, were in fact orderly, law-abiding members of the system like the planets themselves.

Is this then a final solution? Is the law of gravity as enunciated by Newton to be regarded as rigorously true, or does it merely form another approximation to the truth? Apparently we may consider it as absolutely true, though from time to time doubts have arisen on this point. The perturbations of Jupiter and Saturn, the secular acceleration of the moon's motion, the behavior of Encke's comet and the motion of Mercury's perihelion have at one time or another given rise to difficulties some of which have never been completely overcome.

But whether or not the law is rigorously true, no progress whatever has been made toward its physical explanation. In spite of all the ingenuity which has been exercised in this direction it remains as much a mystery as in the days of Newton. The true physical explanation is one of the great problems whose solution is still in the future.

In this development we have noticed a few names which stand out in bold relief. Hipparchus, Copernicus, Kepler, Newton. Are these the only ones to whom credit is due for the creation and development of this department of science? By no means; the astronomer who accumulated observations, the mathematician who helped to perfect the methods of research, and the student of mechanics all contributed to this end and are all entitled to a share in the glory of victory. As has been said: If the Greeks had not studied conic sections Kepler could not have superseded Hipparchus; if the Greeks had studied mechanics Kepler might have anticipated Newton.

Doubtless many branches of science which will occupy the attention of future investigators are still unborn. The status of many of the younger members of this

family resembles that of the astronomy of Hipparchus. Detached facts have been collected, hypotheses have in many cases been formed as to their relations and the laws governing them. In reference to any one of them the near or remote future may produce a Newton to demonstrate the fundamental law by a rigorous mathematical analysis. Meanwhile any laborer in the particular field who has the patience or skill to make an observation or an analysis or perhaps a contribution to pure mathematics may be entitled to his share in the triumph. Though the amount contributed be small there is a great satisfaction in feeling that your labors have been the means of adding something to the world's store of knowledge.

Mankind is no longer striving to evolve a universal science, or an all-embracing system of philosophy. We now recognize the fact that the same frontier which bounds our knowledge bounds also our ignorance, and as the area of the known increases, in the same ratio do the points of contact with the unknown. Every problem solved calls into being new ones for future struggles, and whether or not the universe is infinite, it is at all events for our purposes inexhaustible, so there is no lack of employment for all who may have the ambition to enter the field.

This society is especially designed to further the cause of science in the colleges and universities. As I understand the matter its most important function is that of offering encouragement and recognition to those who are about entering the arena of active life. We make no distinction between pure and applied science. Our purpose is to strive for the advancement of knowledge and the conquest of nature. The earnest student of truth will find his highest reward in the satisfaction which attends the discovery and recognition of the fundamental laws of nature and the essential unity of all, with the consciousness that he has contributed something, however small the amount, towards a proper understanding of her mysteries.

C. L. Doolittle.
University of Pennsylvania.

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*THE IMPORTANCE OF A LABORATORY COURSE OF PHYSICS IN THE STUDY OF MEDICINE.**

Many medical colleges include in their teaching a course of physics, consisting of lectures illustrated by experimental demonstrations of important principles. Few give a laboratory course in which qualitative and quantitative experiments are made by the students themselves. In order to ascertain approximately how many medical colleges in the United State give laboratory courses of physics, letters were recently sent by the writer to about thirty-five medical institutions asking for information on the subject. Colleges were selected which by reason of standing, endowment, equipment, number of students, etc., were likely to employ the best and most modern methods of teaching. Answers from thirty were received. Only three colleges give the course in question. Some express regret that the course is not given, others hope to see it established.

The medical colleges which give the course are:

Barnes Medical College, St. Louis, Mo.

Dartmouth Medical College, Hanover, New Hampshire.

Medical Department, University of Virginia, Charlottesville, Va.

To this number should be added:

The College of Physicians and Surgeons, Columbia University, New York City.

There are at present approximately 160 medical colleges in the United States, of which only 122 are so-called regular schools, the others being homœopathic,

* Read before the Society of the Alumni of Bellevue Hospital, February 5, 1902.

eclectic, physiomedical, etc.* If the proportion of answers received be taken as a ratio, then ten per cent. of these colleges give a laboratory course of physics. Probably five or six per cent. is a more correct estimate.

Among those that do not give the course are the following:

Cornell, Harvard, Johns Hopkins, Tulane, Rush Medical College (University of Chicago), University of Pennsylvania, and Yale.

The object of this paper is to show that a laboratory course of physics is important in the study of medicine, and also to point out that a course of much value can be completed in a comparatively short time, provided the experiments are properly selected and certain methods of instruction are carried out.

THE IMPORTANCE OF LABORATORY WORK.

The laboratory method of instruction has been recognized as essentially important in scientific, technical and engineering schools, and has grown in favor continually during the last twenty years. It has been adopted in medical colleges in many subjects, including anatomy, chemistry, physiology, and others, where it is also acknowledged to be essential.

Dr. C. S. Minot, of Harvard, in his address at the Yale University Medical Commencement in 1899, spoke thus of the laboratory:† 'Knowledge lives in the laboratory,' and again, 'Our greatest discovery in scientific teaching is the discovery of the value of the laboratory and its immeasurable superiority to the book in itself.'

"A lecture is a spoken book, and must, therefore, also yield to the superior claims of first-hand knowledge."

In physics, laboratory work should be an organic part of a systematic course, and the course should consist of lectures, of experimental demonstrations by the lecturer, and of qualitative and quantitative experiments performed by the students themselves. Such a systematic course has been given to the first-year students of the College of Physicians and Surgeons, Columbia University, since 1893, when it was organized by the Department of Physics at the request and with the cooperation of the Faculty of Medicine. The laboratory part of this course is in charge of the writer and is described below:

THE LABORATORY COURSE OF PHYSICS FOR MEDICAL STUDENTS AT COLUMBIA UNIVERSITY.

The course consists at present of twelve periods of laboratory work of three hours each, followed by a final written examination on the salient points of the experiments performed in the laboratory. At the beginning of the course an introductory lecture is given, in which the object of the course, the methods to be followed, the rules for note-keeping, etc., are fully explained. At the same time, each student is provided with a suitable notebook and a printed form called the 'course-list,' containing a list of selected experiments. The course-list also contains a blank column in which is entered the date when each experiment is performed. The course-list is pasted in the front of the notebook and is of service as an index of the notes in the book. Another printed form, the 'time schedule,' is pasted in the back of the notebook, and in this the student is required to keep a record of each attendance. The time schedule is a help to the student in apportioning his time to the experiments in the course. The attendance is also entered on a general time sheet posted in the laboratory for purposes of laboratory record.

* 'Report of U. S. Commissioner of Education,' Vol. 2, 1898–99.

† 'Knowledge and Practice,' C. S. Minot, SCIENCE, July 7, 1899.

Rules for Note-keeping.—The principal rules for governing note-keeping are as follows: The notes must be a synopsis of the actual work performed and not a description of the experiment. They must be entered in pencil at the time when the experiment is performed, and in accordance with a simple form adopted. Also, they must be accompanied by diagrams illustrating the work, and systematic tabulations of the observations made in the experiments.

The Experiments Performed by the Medical Students.—Each student performs twenty-five experiments, twenty of which are prescribed and five of which he himself selects from the remaining experiments on the course-list. The prescribed experiments have been selected for the purpose of illustrating the important principles of physics which are of value in the study and practice of medicine. These experiments are divided between mechanics, heat, light and electricity. The present list is as follows:

Mechanics and heat:

1. Measurement of distances, inch and millimeter scales.
2. Measurement with the vernier.
3. Measurement with calipers and micrometers.
4. The barometer; reducing the reading to zero temperature C.
5. The analytical balance; weighing by swings and interpolation.
6. The Mohr balance; density of liquids.
7. The thermometer; correction of the boiling-point mark.

Light:

8. Focal length of a convex lens (three methods).
9. Focal length of a concave mirror (three methods).
10. Microscope; magnifying power (two methods).
11. Microscope objectives; tests for spherical and chromatic aberrations.
12. The spectrometer; complete adjustment.
13. The spectrometer; measurement of the angle of a prism.
14. The spectroscope; spectra of metals.
15. The spectroscope; absorption spectra of liquids.

Electricity:

16. Measurement of resistance by the substitution method.
17. Measurement of resistance by the difference of potential method.
18. Measurement of resistance by the Wheatstone bridge.
19. Measurement of electromotive force by the high resistance method.
20. Measurement of current by the voltmeter and the ammeter.

Approximately 160 medical students take the laboratory course each year. On account of this large number it has been found necessary to divide the class into four sections, which attend the laboratory on different days.

SYSTEM OF INSTRUCTION.

Time for completing experiments can be economized by proper direction of the instructor in charge and by proper appliances. In the present case, twenty-five experiments are performed in thirty-six hours, which is less time than is generally allotted to that number of experiments; yet perfectly satisfactory work is done by the medical students. This result is accomplished by the system of instruction employed, which is as follows: To each experiment is assigned a special table in the laboratory on which is permanently kept a set of the requisite apparatus. After the students have attended the introductory lecture they go from one experiment to another until they have completed the list. During the periods of laboratory work, there is one instructor to about every ten medical students, who is constantly giving instruction and directing the work.

Experiment Directions.—Typewritten experiment directions, concise and illustrated by diagrams, are used also, and so placed on the tables that students may easily re-

fer to them. The text of each experiment direction is divided into two parts, each part being subdivided into several paragraphs, as follows:

First part:

(*a*) Object of the experiment.

(*b*) Theory and general explanation of the experiment.

(*c*) Description and explanation of apparatus used.

(*d*) Sources of error, precautions, etc.

Second part:

(*e*) Practical instructions, giving method in detail.

(*f*) Example, showing the form of entry of notes required in the notebook.

(*g*) Explanatory notes, references, etc.

GENERAL UTILITY OF THE COURSE IN MEDICINE.

The course is of value to the student as a means of understanding the great principles of physics that are intimately related to medicine. It has also an additional educational value of a more general nature. Some of the teachings of the physical laboratory are enumerated below. No argument is necessary to emphasize their importance.

The experiments show:

1. The necessity of working with method and with deliberation.

2. The value of precision and the cost of carelessness.

3. The necessity of taking every factor of an experiment into consideration and of attaching proper importance and significance to each.

4. The liability of making mistakes in method and errors in manipulation.

5. The limitations of accuracy in both experimenter and instrument.

6. The significance with respect to mankind of physical properties, forces and laws.

These important points are brought to the notice of the student by even a short course of quantitative experiments in physics, and we maintain that in no other way are they shown with such clearness. The medical student is apt to slight his general scientific training and to devote his entire energies to acquiring only that technical knowledge which he considers will be of 'practical' use to him in his profession. Thorough technical knowledge is necessary, but scientific training is equally important, for only through it can technical knowledge be applied to advantage. Medicine is every day becoming more of an exact science. Those of its departments in which progress has been rapid have demanded and received aid from physics, chemistry and biology.

PRACTICAL UTILITY OF THE COURSE IN MEDICINE.

The laboratory course, besides teaching scientific methods and fundamental laws of physics, has also a value that is distinctly practical for many physical instruments are used in medicine. The physician and the surgeon, moreover, are constantly called upon to devise special appliances, demanding of them a knowledge of physical manipulation and construction that can be acquired only in the laboratory.

As medicine becomes more of an exact science, the tests used in the diagnosis of diseases must be quantitative, requiring instruments of precision, having scales, verniers, micrometers and other measuring devices. Such instruments are used in medicine for the purpose of obtaining exact results. Some of these are enumerated below: The thermometer is one of the most constantly used instruments in medical practice. Clinical thermometers are used for determining body temperature, where an accuracy of at least one fifth of a degree is required; yet frequently they are found to have errors of a whole degree, the chief source of error being due to gradual change in the glass. It is therefore imperative that the physician should have a thorough scientific understanding of this important instrument and the modes of testing it. To the microscope is due the

greatest advancement in medicine. It has been the means of discovering bacteria and showing the minute cells of the body tissues. Accurate medical diagnosis now requires that the bacteria and cells must be counted and measured, demanding of the physicist a further improvement of this essential instrument. The spectroscope has been used recently for the analysis of blood and presents a field for medical discovery.

Many physical instruments have been adapted to the uses of medicine and have been given special names.

The cyrtometer for measuring the curves of the chest, and the æsthesiometer for determining the sensitiveness of the skin, the cardiometer, and the pelvimeter are all only calipers of different designs. Hydrometers and certain graduated vessels are called lactometers, saccharometers, or albuminometers to indicate their special uses. The spirometer, which measures the capacity of the lungs, is usually a modified form of gas meter. The sphygmograph, which records the pressure of the blood, is a registering pressure gauge. The hæmoglobinometer, for measuring the amount of hæmoglobin in the blood, depends on a photometric comparison. In general surgery, levers, screws, clamps, pumps and other mechanical devices are used in many forms. In orthopædic surgery in particular complicated mechanical appliances are employed. These consist of clamps braces and screws which are put together in a variety of combinations. A special appliance is often required for each orthopædic case, requiring of the surgeon a knowledge of the principles of mechanics.

In the study of the ear the tuning fork is used for producing uniform waves of sound, and the acoumeter for measuring the acuteness of hearing, the manometer and the otoscope for observing and testing the mobility of the aural membranes. In the study of the eye a special photometer is used for determining sensitiveness to light, the ophthalmometer for measuring corneal images, the perimeter for measuring the field of vision, and the astigmometer for determining the amount of astigmatism.

Applications of Electricity.—The applications of electricity in medicine are increasing daily. In electro-therapeutics the direct and alternating currents have been used for many years, and recently the high voltage discharge from the static machine has proved valuable for the treatment of certain diseases. Electricity is used for cauterization, for eradicating tumors by electrolysis, and for illuminating the interior of the body in surgical operations. It is used in the production of X-rays, which are constantly employed in both medical and surgical diagnosis. No little electrical knowledge is required to operate X-ray apparatus. This knowledge must be practical as well as theoretical. In performing the electrical experiment in the physical laboratory the student uses, and becomes familiar with, various kind of batteries, different types of galvanometers, resistance boxes, switch keys, and various other forms of electrical apparatus. Some of this apparatus is always encountered when an electrical current is used. These are but examples showing the practical utility of a laboratory course of physics in medicine.

In Conclusion.—The study of medicine is long and difficult, especially when two years of hospital service are superadded to the course before private practice is begun; yet if a laboratory course of physics can be made of much value, the short time spent on it, for example thirty-six hours, seems a comparatively small part of the three or four years of study that are required in medical schools. In 1899 the total amount of work demanded of medical

students, in order to qualify for the M.D. degree, in 26 out of the 156 institutions in the United States was 'over 4,000 hours.'* Inasmuch as the minimum requirement established by the Association of American Medical Colleges in June, 1899, was 'at least 3,300 hours,' it can be assumed that the 26 colleges mentioned above include the institutions of highest standing.

A laboratory course of physics of 36 hours, such as the one given at Columbia University, represents less than one per cent. of the total work required on the 4,000 hour basis.

C. C. TROWBRIDGE.

PHYSICAL LABORATORY,
COLUMBIA UNIVERSITY, N. Y.

SOME PRELIMINARY EXPERIMENTS ON THE MOTION OF IONS IN A VARYING MAGNETIC FIELD.

THE experiments described below were suggested by the negative results of V. Crémieu's search for a force acting on a static charge in a varying magnetic field.† The scheme of the Crémieu experiment may be briefly described by the statement that a disc which was charged to a high potential was suspended in the field of a strongly excited electromagnet. Upon breaking the current the disc should have experienced a force in accordance with the Maxwell equation

$$\text{Curl } E = -\frac{1}{E}\frac{\partial H}{\partial t}. \qquad (1)$$

The quantity of electricity that can be placed on a body of considerable dimensions is comparatively small, so that in the case of the Crémieu experiment e/m was a small quantity.

It occurred to me to use the negatively charged ions in an ionized gas as the carriers of the static charge; in the case of ions e/m is very large, being about 4×10^{17} E.S. An ion, because of its high charge, should move with considerable velocity in a varying field of moderate strength. For the purpose of showing the theoretical magnitude of such ionic motion in such a field I will assume an ideal case. Suppose that a cylindrical vessel is placed in a coil of a few turns through which is passing an oscillatory current of high frequency. Assume that there is a complete vacuum except for one negative ion which at the initial time is at rest at a distance r from the center of the coil. The ion will be acted upon by a force the direction of which will be a circle of radius r about the magnetic center of the coil. Neglecting the centrifugal acceleration and the change in apparent mass due to its motion, if the maximum strength of the field at the position of the ion is 100 C.G.S. and the frequency is 10^6, it may be shown that the ion would execute a harmonic oscillatory motion in a circular path around the center, with a maximum displacement from the position of rest of 20 cm. and a maximum velocity of 13×10^7 cm. per second.

Since for the purpose of experiment, it is desirable to have ions in abundance and a rapidly varying magnetic field, I have made use of the well-known electrodeless discharge in the Tesla oscillatory field, as in this form of discharge the gas is highly ionized and the field is of high frequency. In the actual phenomena the amplitude is of course many times smaller than that calculated above. The ions probably move but a short distance and are then stopped by collisions with the molecules, producing by the collision many other ions which by impact produce yet others and thus the effect accumulates until a strong current, the ring discharge, is produced.

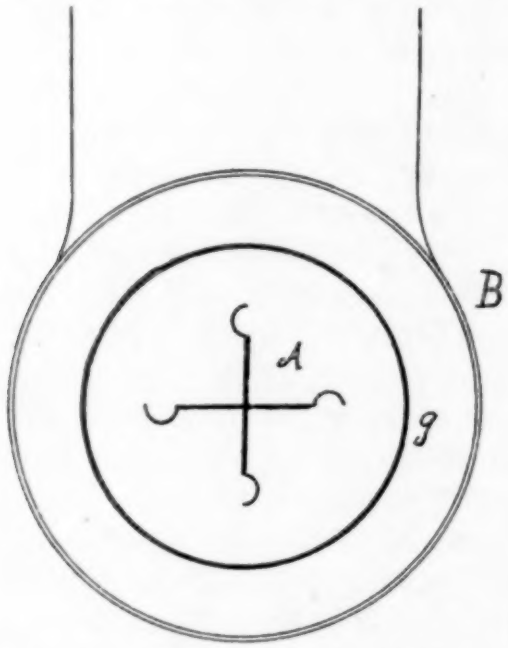
To demonstrate by experiment that some such motion actually exists I have made

* 'Education in the United States,' N. M. Butler.

† Crémieu, *Annales de Chemie et Physique*, 7th Series, I., 24.

use of a miniature anemometer similar to those I have used to show the oscillatory motion of the air in a stationary sound wave.*

The anemometer possesses the convenient property of rotating in one direction, whatever may be the direction of the particles acting upon it, so that an oscillatory motion of the ions should produce rotation provided their amplitudes of oscillation are at least as great as the radius of the cups.



The arrangement of the apparatus was as follows: Four large twenty-liter Leyden jars were joined two in parallel, the inner coatings of each pair being connected with the spark gap and the outer coatings with the coil *B*. Within this coil, which consisted of eighteen turns of coarse wire, was placed a cylindrical glass vessel *g*, 5½ cm. in diameter. The vessel was in permanent connection with a mercury air pump. A miniature anemometer *A*, consisting entirely of glass, was mounted on a needle point so as to turn with great freedom. The anemometer was 3½ cm. in diameter and the cups, which were half cylinders, were each 2 cm. long and 6 mm. in diameter. Between the coil and the vessel was placed a Faraday cage, which was made by attaching narrow strips of tin-foil on a glass cylinder so that the strips were perpendicular to the plane of the coil. This was found to shield the vessel very well from external electrostatic effects. The jars were charged by a large induction coil excited by an alternating current of forty complete periods per second. The length of the spark gap was 11 mm. When the proper degree of exhaustion was obtained, upon the passage of the sparks, the white ring discharge was produced and the anemometer rotated in the direction of the convex side of the cups.

The experiments are given below: Forward rotation signifies rotation in the direction of the convex side of the cups.

1. Pressure 3.6 cm. mercury. A faint red light in vessel. Anemometer does not rotate. Vessel cool.

2. Pressure 1.1 mm. The red light deeper and stronger. The anemometer does not rotate. Vessel cool.

3. Pressure .64 mm. The white ring discharge is obtained. Anemometer rotates forward about two revolutions per second. The vessel becomes very hot.

4. Pressure .17 mm. The anemometer rotates forward but not so rapidly as in experiment 3. After the interruption of the Tesla current the anemometer rotates backward. If the current is kept on for some time, especially when the vessel is wrapped closely in paper to confine the heat, the walls of the vessel become nearly as hot as the vanes of the anemometer and the anemometer rotates but very little backward.

5. Pressure .058 mm. Immediately on the appearance of the white electrodeless discharge the anemometer rotated backward. Upon wrapping the vessel with felt or paper to confine the heat the following is observed: When the current is turned on the anemometer rotates at first back-

* *Amer. Jour. Sc.*, February, 1902.

ward; after a short time it turns more slowly, stops, and then rotates forward. This can be continued but a short time as the temperature becomes so high as to endanger the anemometer.

6. Pressure .024 mm. The anemometer rotated backward, but when the vessel was wrapped with a non-conductor of heat it rotated forward as in experiment 5.

7. Pressure .0017 mm. The electrodeless discharge was not obtained and the anemometer did not rotate. Vessel remained cool.

8. In the experiments 1 to 7 the distance from the outer edge of the anemometer cups to the walls of the vessel was about 1 cm. Another vessel was used also in which the cups were much nearer the walls. With this the backward rotation was much stronger in all cases. The pressure at which the backward rotation was first obtained was much higher than in experiments 4 to 7.

9. In this experiment the vessel contained a small mill which was similar in construction to the anemometer, excepting it had *flat* vanes. This did not rotate at any degree of exhaustion in the strongest discharge that could be obtained.

10. A much larger vessel was used for this experiment. It was 12 cm. in diameter and the anemometer was but 3 cm. in diameter, so that the distance between the walls and the cups was $4\frac{1}{2}$ cm. The rate of rotation was surprisingly great, attaining a velocity of forty revolutions per second. At no degree of exhaustion did the anemometer rotate backward. This indicates that at this great distance ($4\frac{1}{2}$ cm.) between the walls and the cups there is no radiometer effect. It is perhaps desirable also to mention that a vessel was constructed having two anemometers, one above the other, mounted with the convex sides turned in opposite directions. At the proper degree of exhaustion these rotated in opposite directions, each turning in the direction of the convex side of its cups.

The backward rotation appears to be due to the heat interchange between the convex side of the cups and the walls of the vessel, because: (1) By experiment 4, the anemometer is acted on by a force driving it backward, which persists for some time after the current is interrupted. This force is much less when the cups and the vessels reach nearly the same temperature. (2) By experiments 5 and 6, the backward rotation is only obtained when there is heat interchange between the cups and the walls. The effect of wrapping the vessel with a non-conductor of heat is to make the inner surface of the walls nearly as hot as the cups of the anemometer. When this condition is obtained, the backward force nearly disappears and the forward force due to ionic motion predominates.

This backward force appears to be a true radiometer effect since it increases as the vacuum becomes higher. In experiments 3 and 4 the distance from the cups to the walls is probably greater than the mean free path of the molecules and the radiometer effect is small. In experiment 8 the radiometer effect is stronger and appears at a higher pressure as the cups are nearer the walls and the mean free molecular path necessary for a radiometer effect is shorter.

We may regard the molecule from which the negative ion has been separated as a carrier of a positive charge, and so it also will be acted upon by the varying magnetic field. Its velocity and amplitude will be much less than that of the negative ion. The amplitudes will be inversely proportional to the square roots of their masses, since the energy is the same in both cases. If their amplitudes are of the same order of magnitude as the radius of the cups, the positive ions will act on the anemometer also.

There are thus two opposing forces acting on the anemometer, the one due to the motion of the ions and the other due to the transfer of heat from the centers outward. The direction of rotation depends upon which of these forces is in excess. No attempt has yet been made at quantitative measurements, although such measurements could probably be made by a torsional suspension of the anemometer in a vessel as large as that described in experiment 10.

It is my hope in the near future to investigate a possible difference of potential between the walls and the center of the vessel, and also to study the motion of the cathode rays in a Tesla field.

In addition to furnishing direct support to the Maxwell equation, the experiments may be of some value from their bearing on the electron theory of electricity. The electrodeless discharge consists of a rapidly alternating current of electricity similar to that which would be produced in a metal ring placed within the coil. It thus appears that such current is at least accompanied by ionic motion even if such motion does not constitute the current itself.

Bergen Davis.

Göttingen, February 17, 1902.

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*THE TROPICAL LABORATORY AT MIAMI, FLORIDA.**

The extent to which the government of the United States is making provision for scientific investigation in connection with the work of its various departments, notably that of the Bureau of Plant Industry, is a matter of congratulation. To scientific workers especially, it is a gratifying fact that the laboratories established primarily for the study of plant diseases and other subjects of a practical nature are being thrown open to investigators of widely different aims, their facilities being freely placed at the disposal of students engaged in any line of research whatever. One of these, the Tropical Laboratory of the United States Department of Agriculture, has been established so recently and offers such exceptional advantages that its location and facilities should be widely known. This laboratory, located at Miami, Fla., in 1899, was formally established under its present name in 1902. After the discouraging failure of much of the experimental work at Eustis, Fla., occasioned by the disastrous freezes of 1894–95, it became apparent that another place must be selected less subject to climatic vicissitudes, and thus far there is every reason to believe that the location now chosen will admirably fulfil the requirements for such a station.

Miami is situated a little south of the twenty-sixth parallel of latitude, in direct communication with the north by rail, and with Nassau, Havana, and Key West by the Peninsular and Occidental Steamship Line. The city, only a few miles from the Everglades, is healthfully built on the coral breccia which forms the underlying rock, and looks out on Biscayne Bay, landlocked by the northeastern extension of the Florida Keys. Its delightful climate, permitting all sorts of outdoor study and exploration in midwinter, is not the least of its many advantages. The laboratory, situated a mile south of town, is easily reached in ten minutes by wheel over a smooth rock road. Six acres of land belong to the station, upon which experiments in acclimatization and plant breeding are in progress. The laboratory building is a plain but substantial and well-arranged structure, with office and library in which are shelved upwards of two thousand volumes, including pamphlets and periodicals, among which are the *Botanisches Centralblatt*, *Botanischer Jahresbericht*, Science, the *Botanical Gazette* and other current

* Read before the Michigan Academy of Science, March 27, 1902.

literature, largely botanical and horticultural. The director's private laboratory is equipped for chemical, microscopical and bacteriological work, and a similarly situated room is fitted up for the laboratory assistant. A well-lighted room with tables, sink, gas connections and other conveniences is reserved for the use of investigators, and during the past year several representatives of northern universities have availed themselves of the privileges thus offered. The director, Professor P. H. Rolfs, has extended every possible courtesy to myself and others, and has made the conditions for work well-nigh ideal. Although his time is very fully occupied with investigations and experimental work, it is his expressed wish, in accordance with the liberal policy of the Bureau of Plant Industry, that qualified investigators should avail themselves freely of the privileges of the laboratory.

The work now in progress at the Tropical Laboratory includes a continuation of experiments interrupted at Eustis, and many others which cannot be described here. The production of hybrid oranges with a view to obtaining a variety that is hardy and at the same time possessed of other desirable qualities, the breeding of refined strains of the pineapple, acclimatization of promising varieties of mango and other fruits, the adaptation of Peruvian corn to Florida lands, and experimental cultivation of forage plants, grains, and other plants of economical value from all parts of the globe, constitute a portion of the work undertaken, no small part of which has reached a point at which a successful issue may be hopefully anticipated.

Recurring to the opportunities offered to students of biological problems, more particularly those in which botanists are interested, there are certain lines of work specially favorable for extended study, largely on account of the great wealth of material always close at hand. One of these involves further investigation of climatic influences in determining both the range and habits of plant species. The whole matter of acclimatization and the limits within which given varieties are capable of normal development is of such obvious economical importance that it has become, as already noted, a leading subject of investigation on the part of the Bureau of Plant Industry, but the habits and structures of native species, in evident adaptation to rainfall and other factors, though so striking as to attract the attention of every intelligent observer, have been very inadequately studied. The great preponderance, in southern Florida, of one particular mode of adaptation to xerophytic conditions and the partial adoption of this form by species not yet fully adapted to their surroundings suggest one of the many fruitful lines of study that are offered here under most favorable conditions. Equally important, and doubtless quite as promising, is a study of soil conditions, which here plainly exert a marked and even determining influence on the vegetation of particular areas. So apparently simple a matter as a demonstration of the origin of the 'hammocks' has not yet been accomplished. Their interesting and obvious resemblance to islands, as pointed out by some writers, is highly suggestive, but gives no account of their actual history.

The investigation of these and similar questions will naturally be accompanied by a more extended comparison than has yet been made of specific and representative forms common to southern Florida on one hand and the West Indies and more northern regions on the other. Such a comparison should involve much more than a mere enumeration of common species. Differences of form and habit, requiring for their observation some degree of expert knowledge, must be noted where the plants are

growing, since in many cases herbarium material is entirely inadequate for the purpose.

Without attempting further enumeration or suggestion, it may be said in brief that for the study of tropical and semitropical plants, both native and introduced, the investigation of habit and structure as adaptations to both climatic and edaphic factors, and the demonstration of various existing facts of plant distribution as a phase of geological history now in progress, the Tropical Laboratory at Miami offers advantages that can hardly fail to attract and reward earnest students for years to come.

V. M. Spalding.

Miami, Fla.,
February 27, 1902.

HENRY MORTON.

The death, in New York city, May 9, of Dr. Henry Morton, President of the Stevens Institute of Technology, removes from the stage one who cannot be replaced either in the field of his work or in the hearts of his friends. Nor can his work be fully appreciated by any one man or by any one class of men, so varied has it been in character, in its fields of action and in its specialization.

Physicist and engineer; chemist and educator; investigator and legal expert; linguist, editor and writer; man of business and philanthropist; pioneer in the reduction of the art of the mechanic and inventor to a professional and scientific form; mechanic, inventor and organizer and administrator: his many-sidedness necessarily precludes alike appreciation, correct judgment and exact quantitative measurement of his life's work. Whoever studies the life of the man and endeavors to weigh his work and its productive value to the world will at least conclude the investigation impressed with the conviction that this was the rarest of rare cases, that of the man of genius, at once brilliant and versatile, and fruitful of good works in many departments ordinarily supposed to be far separated, as vocations, by the constitution of the human mind. But heredity, environment and an irrepressible ambition conspired with extraordinary powers to make this life fruitful, both in opportunity and in accomplishment.

Henry Morton was born in New York city, December 11, 1836, the son of the late Rev. Henry J. Morton, Rector of St. James' Church, Philadelphia, and the grandson of Col. James Morton, a patriot of the Revolution, inheriting strength and talent from earlier generations of well-known families. He was educated at the University of Pennsylvania.

While still an undergraduate he undertook with classmates the translation of the parallel texts of the famous Rosetta Stone. Mr. C. R. Hale translated the Greek and the Demotic texts and Morton the hieroglyphics. Young Morton also made the smooth manuscript and illuminated it with a skill and taste which proved his inheritance from his father of remarkable artistic ability. This work was published at the suggestion of Henry D. Gilpin, later U. S. Attorney-General, and was edited by Morton, who actually reproduced the manuscript on the lithographic stone and all its illustrations. The extraordinary task was completed and the book issued from the press in the latter part of the year 1858, a volume of 172 pages with 100 illustrations. The book remains one of the famous and rare works in its department. It was commended in enthusiastic terms by Baron Humboldt.

On leaving college, Morton delivered the valedictory address and in admirable verse. His talent as poet continually came to the surface, even in later years and in the midst of the most engrossing occupations.

He entered upon the study of law, which he soon deserted, compelled by his inclination toward the physical sciences, the study and the practical investigation of which, together with mechanical occupations, had been his habitual amusements from childhood. He began his life as educator by accepting a lectureship at the Episcopal Academy of Philadelphia, his own preparatory school. He instantly became distinguished as a lecturer, and his clearness of demonstration and the brilliancy and ingenuity of his experiments, at the time unprecedented, continued to contribute to his fame throughout his life and were never excelled, if ever equaled, by later and noted scientific lecturers.

In 1863 he became Professor of Chemistry at the Philadelphia Dental College, in 1864 Secretary of the Franklin Institute and in 1867 the Editor of the *Journal of the Franklin Institute.* Meantime, his public lectures attracted enormous audiences and his ingenious, original and tremendously impressive experimental illustrations gave him a standing beside Tyndall as a popularizer of science and perhaps placed him fairly above that great genius in this feature of his lectures.

As editor of the *Journal of the Franklin Institute,* Morton accomplished an admirable work. He secured the contributions of men of science and of technical and industrial writers foremost in their respective departments, and his journal soon commanded the respect of the great authorities on both sides of the Atlantic. This periodical, founded in 1826, is quite as well known abroad as at home, and files may be found throughout Europe. It had long been accepted as a leading organ of technically applied science; but, under the direction of the young and active and talented man now coming to the editorial chair, it became still more widely known and exchanged with the important scientific and technical periodicals of all countries. The Abbé Moigno, editor of *Les Mondes,* the well-known French journal of science, Dr. Schellen and many other famous men of the time were among the friends made by the young editor through his work on the *Journal.*

In 1868, Professor Morton was made *ad interim* Professor of Chemistry and Physics at the University of Pennsylvania, in the temporary absence of Professor Fraser, and, in 1869, he was given an independent chair of chemistry. In the latter year he took part in the work of the U. S. Solar Eclipse Expedition and obtained exceptionally fine photographs of the eclipse. He discovered and explained the cause of the bright line on the disk of the sun beside the edge of the moon. This he showed to be purely a photographic phenomenon. His work attracted the attention and commendation of Airy, De la Rue and other astronomers. His pen was prolific of original and useful papers at this time, and their almost invariable reproduction abroad testified to their admitted value among men of science throughout the world.

In 1870 came Morton's great opportunity. By bequest, Mr. Edwin A. Stevens, of Hoboken, had provided for the foundation of 'an institution of learning' which was to be organized for the benefit, particularly, of 'the youth of the State of New Jersey.' The testator and his executors were alike without any definite idea of the form most desirable for such an institution. Professor Morton was consulted and, at his suggestion, the trustees concluded to make the new 'institution of learning' a school of mechanical engineering. At the time, as Morton pointed out, there were schools of civil engineering practically competent to supply all the instruction then demanded by aspirants for admission to that branch of the profession of engineering; but there were no

schools of the mechanic arts and of mechanical engineering, while the requirements of the rapidly growing industrial system were certain to make an early and imperative demand for professionally trained mechanicians and engineers. This prophecy was soon shown to be correct.

President Morton took his place as the head of the new school in 1870, promptly selected his faculty and organized the institution, in accordance with the accepted plan, in 1871. Its success was instant and the thirty-two years which have elapsed since the foundation of the Stevens Institute of Technology have seen steady progress in numbers and in quality of its alumni, in the character and extent of its curriculum and in the amount of fruitful research and valuable engineering data experimentally obtained through the able and unintermitted work of its faculty. It promptly assumed and permanently retained a place among leading professional schools.

The president set an admirable example of enterprise and industry and his life, from this time on, was one of great productiveness. The administration of the college, the prosecution of experimental investigations and the studies compelled by calls upon him for testimony in the courts as an expert in the departments of applied science, in which work he soon became, as everywhere, distinguished, completely put an end to his public lectures and reduced his authorship to a minimum. The new institution, however, was always a first consideration and he was always ready to make any personal sacrifice to insure its successful development.

In the early days of this period, Morton carried on his scientific researches as best he could in the midst of the constant calls of duty and the distractions of a busy life. He studied the fluorescence and the absorption spectra of over eighty uranium salts, publishing results on both sides the Atlantic. In 1873 he similarly studied the petroleum products, anthracene, pyrene, chrysene, and published valuable papers regarding them in the years 1872 to 1874. He discovered 'thallene,' and its modification 'petrolucene'; which substances have extraordinary fluorescent properties. His inventiveness was illustrated in everything undertaken by him; but one of his most useful devices was his new form of projection lantern, permitting the exhibition on the screen of a great variety of experiments which, previously, could not be satisfactorily displayed. This apparatus greatly interested Professor Hoffman, who visited the country a short time after its production. He independently discovered 'flavopurpurin,' though himself crediting Auerbach with its first production. It proved, later, that Auerbach made 'isopurpurin,' a mixture of anthrapurpurin and flavopurpurin. The demands of expert work led the young chemist and physicist into many interesting and often important researches, and his coolness, courage and entire confidence in his plans and processes were often strikingly exemplified, as by his work in distillation of nitroglycerine and in conducting investigations involving the employment of steam at above twenty atmospheres' pressure.

His expert work proved a lucrative as well as an attractive and interesting field for the display of his talents and, vastly more important from his own point of view, it gave him means for promoting the success of his college of engineering. He turned back into its treasury probably the full equivalent of the salary of the president, and never allowed an important opportunity to advance the work of the Institute to pass for want of funds when he could supply them. Besides many smaller and often unnoticed contributions, he provided, in 1880, a new workshop; in 1883 he

organized at his own expense a Department of Applied Electricity; in 1888 he organized the Department of Engineering Practice, in both cases contributing liberally toward the equipment and endowment of the new chairs. In 1892 he placed an additional $20,000 in the hands of the trustees for this last-named department. Later, at the celebration of the twenty-fifth anniversary of the organization of the institution, he gave it about $25,000, in 1900 $15,000 and again in 1901, $50,000. His total contributions to the funds of the college probably amounted to $150,000, including numerous small and unrecorded gifts of apparatus.

President Morton in 1878 was elected a member of the U. S. Lighthouse Board, filling the vacancy produced by the death of Professor Henry. He was a member of the National Academy of Sciences from 1873. He was Ph.D. (Dickinson, 1869, Princeton, 1870) and in 1897 was made D.Sc. (Pennsylvania) and LL.D. (Princeton). He was a member of many learned and technical associations, at home and abroad.

The personal character of President Morton compelled respect and admiration. Cultured, scholarly, acute and brilliant, he exhibited in every way intellectual superiority. Broad-minded, of good judgment and possessing unusual force, his moral side was admirable and impressive. He was generous to a fault, liberal in sentiment, and devout. At home in all social relations and adapting himself to any society, he influenced strongly every person with whom he came in contact and his welcome was warmest in the most intellectual gatherings. His fine personality and his earnestness in the pursuit of his lofty aim compelled the sympathy and induced the active cooperation of Mr. Carnegie, and the most important and most valuable and productive of accessions to the equipment of his college was the recently erected 'Carnegie Engineering Laboratory.' He was himself generous to a fault in other directions than the promotion of technical education, and his friends and neighbors, both at his home in Hoboken and in his summer home at Pine Hills, testify to his constant and liberal contributions to all good works; so quietly and unobtrusively were these private philanthropies conducted, that it is probable that very few of his friends were aware of their extent.

The death of President Morton is an event of serious importance as a loss to science, to the cause of education and to a large social circle; it is a catastrophe for the institution over which he presided for so many years and which he brought to such a prominent position among professional schools, and to his family and friends. He will always have a memorial in his valuable contributions to science, and the already famous school organized by him will permanently stand a monument of larger real value and importance than that construction which commemorates its architect with the inscription '*Si monumentum requiris, circumspice.*'

R. H. THURSTON.

SCIENTIFIC BOOKS.

Hygiene for Students. By EDWARD F. WILLOUGHBY, M.D. London, Macmillan & Co. 1901. Pp. 563.

This excellent volume appears under a new title, but is in reality a fourth enlarged and improved edition of his 'Principles of Hygiene' first published in 1884. Dr. Willoughby needs no introduction to the American reader, since he has been for a number of years the European editor in charge of the Department of Hygiene and Public Health in the *American Journal of the Medical Sciences*, and we may expect therefore that he speaks authoritatively on all matters pertaining to his specialty. The volume is divided into six parts and twenty chapters. Part I. deals

with the health of the man, and chapters one to six treat of the food-stuffs, stimulants, condiments, cooking and preparation of food, clothing, habits, exercise, rest, etc. Part II. is devoted to the health of the house, with chapters on sites and aspects for dwellings, ventilation, heating, lighting, plumbing, etc. Part III. deals with the factors which influence the health of the city, such as water supplies, sewerage and scavenging of towns. Part IV. deals with the health of the people, more especially the preventable diseases; chapter seventeen is devoted to school hygiene, and chapter eighteen to the health of the workshop; chapter nineteen to vital statistics and tables of comparative mortality, and chapter twenty to meteorology and climate. The presentation of the subject is clear, concise, logical and exact, and the student cannot fail to be impressed with the value of such a work. The summary of each chapter and the questions on each chapter will also serve a very useful purpose, in so far as they emphasize the salient points discussed.

In his chapter on food-stuffs, he points out the injurious effects of an excess or undue preponderance of one or the other of three principal alimentary principles, viz., the albuminates, fats and carbohydrates, which should prove of great practical value.

The chapter on stimulants and condiments is a very able presentation of the physiological effects of these so-called accessory foods, which when taken in moderation are what the Germans call 'Genussmittel,' or means of enjoyment, as contrasted with the true foods or means of nourishment. The author's views on the subject of the use and abuse of alcohol are quite in accord with scientific facts, and his summary reads: 'Alcohol is a stimulant for good or ill, in excess narcotic, habitual excess leads to degeneration of the tissues, especially of the brain and liver.'

Our knowledge of the effects of alcohol may be summed up as follows: In moderate and diluted doses it evidently stimulates digestion, as shown by its beneficial effects after a hearty meal, but large quantities interfere with or arrest the peptonizing process and frequently produce acute gastric catarrh. These effects are observed when alcohol is present to the extent of 10 per cent. of the gastric contents. Alcohol also exerts a marked diuretic effect which is due to a direct irritation of the renal epithelium. The habitual use of immoderate doses produces chronic gastric catarrh, with consequent impaired digestion and nutrition. It produces fatty degeneration of the heart, liver and arterial coats, probably because it promotes the conversion of albuminoids into fats, the connective tissue of the body increases in amount and its subsequent contraction gives rise to cirrhosis of the liver, Bright's disease and chronic meningitis. Alcohol also produces structural changes of the cells of the brain and spinal cord and leads to a general physical, mental and moral deterioration, which is often transmitted to the offspring.

On the whole we may conclude that alcohol is an accessory food of value only when it becomes necessary to increase temporarily the elasticity of mind and body and a desire and capacity of work, but the subsequent depressing effects and the baneful influence of its misuse should make us careful in its employment even for therapeutic purposes, especially when rest, proper food and some of the alkaloidal beverages and stimulants may accomplish the same purpose. For persons in health, alcohol in any form presents no advantages not found in other food-stuffs or stimulants, and which are, moreover, free from the dangers attending its use. While it is quite true, as expressed by Dr. Gairdner, that alcoholic drinks are at times a very enjoyable and harmless luxury when honestly tested by experience and kept within bounds by reason and prudence, the facts are that during the past decade there has been a marked increase in this country in the rate of Bright's disease, heart disease, dropsy and pneumonia, and the immoderate use of alcoholic beverages may be a factor in the development of these diseases.

Chapters six, seven, eight, nine and ten on habits, exercise, rest, sleep, idiosyncrasies, heredity and the hygiene of habitations are of special interest to the general reader.

Chapter ten on potable waters and the ef-

fects of impure water; Chapter twelve on water purification, and Chapter thirteen on scavenging of towns and sewage disposal, are very complete indeed for a book of this size. Under the head of sewage disposal he has withdrawn all descriptions of the chemical methods of treatment, but has very fully explained the theory and working of the bacterial tank and filters, which he very justly maintains should be adopted wherever irrigation cannot be advantageously carried out. His discussion of river pollution by the general introduction of sewage and the wastes of human life and occupation is brief, but sufficiently pointed to show that few streams can be used with perfect safety as sources of public water supply.

In speaking of the disposal of the dead, the author makes a strong plea for cremation, but deems it in the highest degree improbable that, for many generations at any rate, there will be any appreciable change in the practice of interment, sanctioned as it is by usage, sentiment and prejudices. He considers the fear that cremation would, by precluding subsequent examination, serve to conceal, if not offer an inducement to, crime as exaggerated or groundless, and shows how cremation might be made to lead to the detection of crime as it has already done in Italy, by exacting a more rigid system of certificates of death from the medical attendant, and in doubtful cases a post-mortem examination.

Chapters fifteen and sixteen, on preventable diseases, immunity and disinfection, are fully up-to-date and of great value, as is also the chapter on school hygiene, especially the discussion of the excessive and misdirected mental work. His long and practical experience as a physician, sanitarian and school manager entitles him to speak with authority on the subject. His chapters on the health in the workshop, comparative mortality of various professions and trades, meteorology, climate and health resorts contain a fund of useful information not generally found in a work of this character. On the whole the student of hygiene is to be congratulated upon the appearance of this very accurate and complete book.

GEO. M. KOBER.

Forstästhetik. By HEINRICH VON SALISCH. Berlin, Julius Springer. Second edition. Octavo, paper cover. Pp. 314. Illustrated with sixteen full-page heliotypes and fifty-nine half-tones and figures.

This book treats of woodland scenery in its relation to the science of forestry. The author describes in detail the scenic beauty of the artificial forests of Germany. These have long been subjected to systematic methods of treatment, and although the ostensible object has been solely to increase the practical value of the forests, they have incidentally been given a distinctive character that is well worth our study. The subject should interest Americans because the forestry movement that is now so rapidly gaining ground in the United States must, in its practical application, ultimately affect our wooded landscapes.

The book comprises two parts, the first of which opens with an introductory chapter on the relation between the economic and the æsthetic aspects of forestry. Then follow several chapters on the nature of beauty and our capacity to understand its various modes of expression. The remainder of Part I. shows how this beauty is revealed by the various components of the forest.

In Part II. the author enters into a careful discussion of the æsthetic effects that are due to the various operations of forestry, such as the construction of road systems, the choice of species in renewing the forest, the methods of sowing and planting, and the different systems that regulate the cutting of the timber. The concluding chapters treat of certain principles of landscape art that in the author's opinion may advantageously be applied to the practical forestry of Germany.

The author is thoroughly familiar with his subject in its utilitarian as well as its æsthetic aspects, and has produced a work of decided value. His manner of treatment shows exceptional powers of discrimination, particularly in matters of taste. The book contains many extracts from writers who have incidentally touched upon forest æsthetics, thus affording an opportunity for a broad but liberal criticism of the various points of view. While Mr. von Salisch therefore does not

claim originality for some of the ideas advanced, and while it may even be said that his book is in several respects incomplete, he has at least given unity and connection to the scattered materials at his command. Moreover an interval of seventeen years, which has elapsed between the first edition and this second appearance of the work, has enabled him to enrich it with many new thoughts and suggestions and to add a number of beautiful and interesting illustrations.

Mr. von Salisch's book is unique in that it presents the first comprehensive discussion of forest æsthetics. It will commend itself to landscape artists, in spite of the fact that certain portions are technical and can be thoroughly understood only by persons who are familiar with the subject of forestry. It should have distinct value for the student of æsthetics, especially Part I., which contains many interesting suggestions regarding the philosophy of beauty. But to the professional forester 'Forstästhetik' should prove especially valuable and interesting because it throws a flood of light upon the broad possibilities of his profession. As our country is devoting more and more attention to conservative forestry, he naturally asks how his work will affect the natural beauty of our landscapes. 'Forstästhetik' shows him how the beauty of a forest may be brought out to special advantage by a forester of taste without affecting its usefulness, and is thus calculated to give him a clearer insight into the scope and dignity of his profession.

G. Frederick Schwarz.

Bureau of Forestry.

Elementary Zoology. By Vernon L. Kellogg. New York, Henry Holt and Company. 1901. Pp. xv+492.

Kellogg's 'Elementary Zoology' is planned to meet the requirements of a laboratory guide and of a reading text in introductory zoology. The book is divided into three parts: the first dealing with the structure, functions, and development of animals, the second with systematic zoology, and the third with animal ecology. The text proper is followed by appendices on the needs of the pupil, the equipment of the laboratory, and the rearing of animals and the making of collections. The volume is concluded by a good index to subjects and illustrations.

Judged from the standpoint of a laboratory guide the book gives a wide selection of types, and these are dealt with in an unusually satisfactory way for an elementary treatise, the descriptions being neither too exhaustive nor too superficial. Everywhere, however, too much information is given the student. Why ask if the alimentary canal of the toad (p. 8) is uniform in character, and in the same paragraph describe the stomach as an *enlargement,* the small intestine as *slender,* and the large intestine as *larger* than the small intestine? With figures and with descriptions of this kind the book is bound to sap most of the life from the laboratory work. A good laboratory guide should be built upon leading questions, which incidentally include a good terminology, and it should be in the main without illustrations. It follows from this that a book designed to be of an informational character and also a laboratory guide is bound to be somewhat of a failure in one direction or the other.

From the standpoint of an elementary reading text much can be said in favor of the volume. It is written with unusual accuracy and the small errors so commonly met with in elementary works of this kind are here noticeably absent. The defects are chiefly omissions. It seems hardly fair to use the title zoology for a book that nowhere contains even a brief exposition of the animal body as a working machine, and that from cover to cover makes no mention of the host of animal forms known only as fossils. Of course, the chief task of the author was to omit, but it seems scarcely wise to carry this to the point of excluding the fundamental results of animal physiology and of paleozoology.

As a piece of book-making the volume is serviceable. The search for novel illustrations has often led to the use of poor photographs where good drawings would have been much better. It is questionable whether the pupil will gain much from such a figure as that of

the cross-section of the pupa of a bee (p. 199) and the expert will certainly not regard an illustration of this kind as a triumph of the art of photomicrography. Nevertheless many of the figures, particularly those in the chapter on birds, are of an unusually high order. Although the book cannot be described as a well-balanced zoology, and is open to serious objections as a laboratory guide, its clear and truthful presentation of many elementary facts will certainly gain for it a wide circulation.

G. H. PARKER.

HARVARD UNIVERSITY.

SCIENTIFIC JOURNALS AND ARTICLES.

WE note a little tardily *The Plant World* for March which contains articles on 'American Botanical Gardens,' by John W. Harshberger, a sketch of Lewis David von Schweinitz, by C. L. Shear and John Stuart Mill and 'Botanical Study,' by E. J. Hill. In the supplement Charles L. Pollard continues the description of the families of the Order Ericales.

The Osprey for April has a paper on 'The Feeding Habits of the Coot and Other Water Birds,' by Barton W. Evermann, and one on the 'Birds of the Marianne Islands and their Vernacular Names,' by W. E. Safford. The supplement, devoted to the General History of Birds, discusses the question of molt.

The Museums Journal of Great Britain for April has a flattering article on 'The Museums of Chicago,' by F. A. Bather, being a review of Dr. Meyer's memoir. But it is to be feared that we are not so well up in the matter of museum methods and general appreciation of museums as Mr. Bather thinks: it is one of the numerous cases of distance, etc. William E. Hoyle notes 'Some Useful Applications of Card Catalogues' and we have the usual number of interesting notes which do credit to Mr. Howarth's industry as an editor.

THE publication of the *Biological Bulletin* will be resumed in June, when the first and second parts of Volume III. will be issued. It will be published as heretofore, under the auspices of the Marine Biological Laboratory, and its scope will include zoology, general biology, and physiology. The editorial staff consists of Professors E. G. Conklin, Jacques Loeb, T. H. Morgan, W. M. Wheeler C. O. Whitman, E. B. Wilson and Frank R. Lillie, managing editor. In regard to the *Bulletin* Professor Lillie says: "There is in America no journal that takes the place of the *Biologisches Centralblatt* or the *Anatomischer Anzeiger* in Germany, although there is abundance of material to support such a publication. It is hoped that the *Bulletin* may occupy this field, and meet the need for rapid publication of results; the editors, therefore, undertake to issue one number each month, making two volumes a year, if the material offered is sufficient. The subscription price of the *Bulletin* has been fixed at three dollars for a volume of 300 pages; the low price makes it necessary to limit the length of the articles, and to exclude all lithographic plates. In no case will articles of more than twenty-five pages be included in any single number; but, in some cases, longer articles may be accepted, and published in installments. The cost of illustrations above $10 for any single article will be charged to the author, as will also be the cost of unusual alterations in the proof. The *Bulletin* will undoubtedly meet a real need; but the responsibility for its success rests with American biologists, and the editors therefore confidently appeal to them for their support. This can be most practically given in the two forms of subscriptions and contributions to its pages." All communications, subscriptions, and manuscripts should be sent to the managing editor, the University of Chicago, September 15 to June 15, or Wood's Holl, Mass., June 15 to September 15.

The Journal of Mycology, of which seven volumes were published from 1885 to 1894, is now resumed by Dr. W. A. Kellerman, Ohio State University, Columbus, Ohio, at the former price, namely, one dollar per year. It will be issued quarterly, the May number being the first for 1902 (Vol. 8); but the second number will appear early in June.

SOCIETIES AND ACADEMIES.

AMERICAN PHYSICAL SOCIETY.

THE April meeting of the Physical Society was held at Columbia University on April 21,

this date being chosen instead of the usual one on account of the reception tendered on that day to the Society's only honorary member, Lord Kelvin. The meeting was the most largely attended in the history of the Society. The program, which was so extended as to make it hardly practicable to give an abstract of the individual papers, was as follows:

'Note on the Specific Heat of Mercury': H. T. Barnes.

'On the Theory of Concentration Cells': H. S. Carhart.

'An Apparatus for the Quantitative Study of Sound': A. G. Webster.

'The Magnetic Deviation of Rays from Radio-Active Substances': E. Rutherford and A. G. Grier.

'The Condensation of Nuclei': Carl Barus.

'A New Gravity Electrical Time Key': Chas. Forbes.

'An Electrical Method for Calibrating Chronographs': H. C. Parker.

'Absorption Curves for Condensers for Very Short Time Intervals': H. C. Parker.

'Residual Magnetism in Iron and Steel for Very Short Intervals of Time': C. C. Trowbridge.

'An Experiment Relating to the Application of Lagrange's Equations to Electric Currents': W. S. Day.

'The Physical Meaning of Mathematical Operations in Heat Conduction': A. S. Mackenzie.

'A New Method of Integrating one of the Differential Equations of Heat': R. S. Woodward.

'An Instrument for Drawing a Sine Curve': A. S. Mackenzie.

'Three Lecture Experiments': W. S. Franklin.

Ernest Merritt,
Secretary.

PHILOSOPHICAL SOCIETY OF WASHINGTON.

The 552d regular meeting was held April 26, 1902. Mr. W. J. Spillman, of the Department of Agriculture, described 'A Machine for producing Normal Equations from Observational Equations.'

The work to be done in this case consists in multiplying each equation through by the coefficient of a given term of the equation, and in collecting the new coefficients of homologous terms into sums which are the coefficients in the normal equation. The method here described is applicable to cases where the number of terms in the normal equation is not greater than four. The machine contains a number of levers, pivoted at center, and graduated each way from the center to 10. The length of the graduations is arbitrary. Each lever is provided with four indicator slides, two on each side. The slides are set so as to point out on the lever scale the coefficients of the terms of an observational equation. The lever is then said to be set for that equation. From the slides cords pass upward to four systems of pulleys, in such manner that moving the levers vertically causes each cord to actuate an index finger attached to the uppermost pulley in each system. A convenient scale is arranged near one end of the lever, and is graduated into ten equal divisions, numbered from 0 to 10. The lever being raised from the zero to any point on this scale causes the index fingers to move on four similarly graduated arcs, and to point out on these scales the products of the coefficients by the number to which the indicator on the end of the lever points.

Other levers are set for other observation equations, as above. When any lever is raised so as to point to the number by which its equation is to be multiplied, the new coefficients of that equation are added to those already produced. When all the levers that are set are properly adjusted, the index fingers point out the coefficients of the normal equation.

A similar machine had proved very useful in problems requiring multiplication and summation of corresponding products.

The next paper was by Mr. L. J. Briggs, also of the Department of Agriculture, 'On the Absorption of Gases and Dissolved Salts by Quartz and Glass.'

In one series of experiments very finely powdered quartz was used and the weights of water vapor or carbon dioxide absorbed thereby were determined; these were found to be closely proportioned to the pressure of the vapor or gas. Similarly experiments were made with very dilute solutions of chlorides, carbonates and hydroxides of sodium, potassium and ammonium. The quantity absorbed increases much less rapidly than the concentration and appears with these salts to be dependent on the acid radical rather than upon the basic ele-

ment. The importance of such investigations in their relations to soil-physics and scientific agriculture was pointed out.

Erratum.—In the report of the 551st meeting (SCIENCE, May 2, 1902, page 710) the statement regarding the consumption of liquid air should read fifty gallons per week.

CHARLES K. WEAD,
Secretary.

THE SECTION OF GEOLOGY AND MINERALOGY OF THE NEW YORK ACADEMY OF SCIENCES.

THE Section met on the 24th of April, and listened to the reading of two papers, abstracts of which follow:

Lea McI. Luquer, 'On the Determination of the Relative Refractive Indices of Minerals in Rock Sections by the Becke Method.'

In most schemes for the optical determination of minerals in rock sections, the birefrigence and resulting interference colors are made the basis of the scheme of classification. It is also desirable, however, to bring into consideration an approximate knowledge of the indices of refraction, and where the relative differences in the indices of two adjoining minerals are required, the method devised by Becke is found to be very convenient. This method depends upon the principle of the total reflection of light, and with proper adjustment of the microscope, which is to be focused sharply on the dividing plane between the two minerals, it is possible by slightly raising the objective, to observe a 'bright line' on the side of the mineral having the higher index of refraction.

The main precautions to be observed are that the cone of incident light be small, the sections very thin, the cementing material not much lower in refractive index than either of the minerals to be determined, and the plane of contact clear and nearly vertical. When the contact plane is much inclined, the method cannot be applied.

By this method very slight differences in refraction can be distinguished; as for example, between quartz sections cut parallel and at right angles to the optic axis with the difference

$$\varepsilon - \omega = 0.009, \quad \varepsilon = 1.553, \quad \omega = 1.544$$

Dr. Luquer's paper has been published in the *School of Mines Quarterly* for January, 1902, pages 127–133.

Austin F. Rogers, 'The Minerals of the Joplin, Mo., Lead and Zinc District.'

The minerals of the Joplin district include sulphur, galena, sphalerite, covellite, greenockite, wurtzite, chalcopyrite, pyrite, marcasite, quartz, cuprite, pyrolusite, limonite, calcite, dolomite, smithsonite, cerussite, aurichalcite, hydrozincite, malachite, azurite, calamine, muscovite, chrysocolla, allophane, pyromorphite, barite, anglesite, leadhillite, caledonite, linarite, gypsum, goslarite, chalcanthite, melanterite, copiapite and bitumen, all of which have been found by the writer.

Lamellar twinning has been observed in galena, the twinning planes being vicinal tetragonal trisoctahedra. Covellite is found replacing sphalerite. Wurtzite occurs in distinct hemimorphic crystals, the first instance of the kind to be reported. Twin crystals of marcasite are common, among them cyclic fivelings. Quartz crystals are rare and small. Calcite presents an interesting field for crystallographic study, about twenty-four types with a total of twenty-nine crystal forms having been noted. Twinning according to all of the four laws for calcite has been observed. Some distinct crystals of aurichalcite confirm D'Archiardi's observations that the mineral is monoclinic and that the axial angle β is not 90°. Calamine occurs in doubly terminated crystals which show their hemimorphic character plainly. Seamon's theory as to the formation of calamine from 'tallow-clay' is not in all cases applicable. The rare copper-lead basic sulphates, caledonite and linarite, occur at one mine at Galena, Kansas. This mine also furnishes covellite, cuprite and aurichalcite.

The observed paragenesis generally follows this order: dolomite, galena, sphalerite, chalcopyrite, marcasite, pyrite, barite, calcite. The total absence of certain silicates and the rarity and small size of the quartz crystals strongly preclude the theory that the lead and zinc ores have been brought up from great depths by hot waters.

Attention was called to the coincidence in

the location of the ore deposits of this and neighboring districts and the border areas of the Ozark uplift, as pointed out by Haworth.*

A fuller discussion of the minerals noted in this paper and their occurrence will be found in the forthcoming 'Lead and Zinc Report of the University Geological Survey of Kansas.'

EDMUND O. HOVEY,
Secretary.

THE ACADEMY OF SCIENCE OF ST. LOUIS.

AT the meeting of May 19, 1902, fifteen persons were present. Professor C. M. Woodward presented some notes on the 'Stresses in a Rotating Disk,' from which it appeared that the stresses in such a disk, as, for instance, in an emery-wheel or grindstone, when mathematically analyzed, are entirely tangential, notwithstanding the fact that the disk increases in diameter when rotated at a high rate of speed, so that the tendency to fracture is along radial lines. Professor Woodward also discussed the stresses in the disk when bound by a thin cylinder of greater strength and a high modulus of elasticity.

One person was elected to active membership.

WILLIAM TRELEASE,
Recording Secretary.

THE PACIFIC COAST ASSOCIATION OF CHEMISTRY TEACHERS.

THE Association organized last summer, held its first regular meeting as Berkeley, April 26, The Association was started during the session of the summer school of the University of California by a few teachers who were in attendance, and who realized the importance of a better understanding among themselves as to the proper methods of teaching chemistry. During the first six months of its existence a number of 'Circulars of Information' were issued, and the membership steadily increased until it now numbers about fifty. In April the Association had become strong enough to begin to hold meetings for the discussion of subjects of interest to the members. The first meeting was held in the chemistry building of the University of California and was attended by representatives from the principal schools in that part of the state within easy reach of Berkeley. Two subjects had been assigned for discussion, both dealing with the proportion of work that should be done by the teacher and the student respectively. But the discussion took a wider range and covered the entire subject before the meeting adjourned. While there was considerable difference of opinion as to methods, it was the unanimous opinion of those present that it is necessary to emphasize the practical, everyday side of chemistry to make it interesting and attractive to the beginner.

The Association is planning to hold its annual meeting in July during the summer school at the University, when teachers from all parts of California and the other Pacific states gather at Berkeley in large numbers.

EDWARD BOOTH,
Secretary.

UNIVERSITY OF CALIFORNIA.

* *Bull. Geol. Soc. Amer.*, 11: 221, 1900.

DISCUSSION AND CORRESPONDENCE.

THE COMING MEETING OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

UNFORTUNATELY the list of officers of the coming meeting of the American Association in Pittsburgh was dropped by the printer from the paged proofs of the Preliminary Circular, and the omission was not detected until the entire edition had been printed and mailed. That there may be no misunderstanding the list of officers for this meeting is herewith given:

OFFICERS OF THE PITTSBURGH MEETING.

President.

Asaph Hall, U. S. N., South Norfolk, Conn.

Vice-Presidents.

A—Mathematics and Astronomy, G. W. Hough, Northwestern University.

B—Physics, W. S. Franklin, Lehigh University.

C—Chemistry, H. A. Weber, Ohio State University.

D—Mechanical Science and Engineering, J. J. Flather, University of Minnesota.

E—Geology and Geography, O. A. Derby, Sao Paulo, Brazil.

F—Zoology, C. C. Nutting, Iowa State University.

G—Botany, D. H. Campbell, Stanford University.

H—Anthropology, Stewart Culin, University of Pennsylvania.

I—Social and Economic Science, Carroll D. Wright, Commissioner of Labor.

K—Physiology and Experimental Medicine, W. H. Welch, Johns Hopkins University.

Permanent Secretary.

L. O. Howard, Cosmos Club, Washington, D. C.

General Secretary.

D. T. MacDougal, New York Botanical Gardens.

Secretary of the Council.

H. B. Ward, University of Nebraska.

Secretaries of the Sections.

A—E. S. Crawley, University of Penna., Philadelphia, Pa.

B—E. F. Nicholas, Dartmouth College, Hanover, N. H.

C—F. C. Phillips, Western University of Pennsylvania, Allegheny, Pa.

D—C. A. Waldo, Purdue University, Lafayette, Ind.

E—F. P. Gulliver, St. Mark's School, Southboro, Mass.

F—C. W. Stiles, U. S. Department of Agriculture, Washington, D. C.

G—H. von Schrenk, Shaw School of Botany, St. Louis, Mo.

H—H. I. Smith, American Museum of Natural History, New York, N. Y.

I—(To be elected).

K—F. S. Lee, Columbia University, New York, N. Y.

Treasurer.

R. S. Woodward, Columbia University.

Inasmuch as it is always desirable that so far as possible those who attend the meetings of the American Association for the Advancement of Science should be sure when coming of comfortable quarters in which to lodge, I desire through the columns of SCIENCE to emphasize the importance of the recommendation made on page 22 of the Preliminary Circular, that the members of the Association correspond in advance with the proprietors of the hotels and the keepers of boarding houses in order to secure pleasant quarters. There is the more reason for this because of the fact that the President of the United States has signified his intention to be present in Pittsburgh to take part in the celebration of the Fourth of July, which is always celebrated in this city in a manner that is unique. It is highly probable that the city will be resorted to by a large concourse of people from all parts of the country. The sessions of the American Association do not conclude until the 3d, and it would therefore be well for members intending to be present to write at an early date, making sure of their accommodations. There is abundance of room at the service of the members, but prudence dictates that an early application for quarters should be made. In this connection I desire to call attention to the fact that very pleasant lodgings can be secured in the dormitories of the Pennsylvania College for Women, located in a delightful spot. Letters referring to accommodations at the college should be addressed to the Rev. Dr. Chalmers Martin, President.

The fact that the celebration of the Fourth to which I have alluded is practically coincident with the meeting of the American Association should not deter members from attending, but should be an attraction. An 'old-fashioned Fourth' in Pittsburgh is something which those who have witnessed it will never forget.

W. J. HOLLAND,
Chairman, Executive Committee.

AMERICAN CHEMICAL SOCIETY, SECTION C OF THE A. A. A. S.

THE American Chemical Society will hold its summer meeting, as usual, in connection with the meeting of Section C of the American Association for the Advancement of Science. These meetings will be held this year in Pittsburgh, Pa., Monday, June 30, to Thursday, July 3, inclusive. The sessions on Monday and Tuesday will be in charge of the American Chemical Society, with the exception of a short session of Section C, for the purpose of organization, immediately after the general meeting of the A. A. A. S. on Monday morning. The sessions on Wednesday and Thursday will be in charge of Section C.

The various papers presented, whether offered to Section C or to the American Chemical Society, will be classified, in so far as possible, under certain general topics, and in this manner will be distributed among the sessions throughout the week.

Brief abstracts of all original papers to be presented should be forwarded to the committee on program, W. A. Noyes, Terre Haute, Ind., Chairman, as early as convenient, and *not later than June 10.* Papers to be presented at the meeting are not necessarily in the same form as those prepared for publication. For public presentation few details should be given, and papers should consist chiefly of a clear and reasonably concise statement of the results which have been obtained and the conclusions reached. Abstracts should be accompanied with a statement of the time desired for the presentation of the paper. Persons presenting general addresses and reviews under special arrangement with the committee need furnish only a brief outline as an abstract.

Albert C. Hale,
Secretary of the American Chemical Society.
Brooklyn, N. Y.

Francis C. Phillips,
Secretary of Section C of A. A. A. S.
Allegheny, Pa.

ON PYRITE AND MARCASITE.

To the Editor of Science: In your number for November 1, 1901, abstract is given of an excellent paper by Dr. H. N. Stokes 'On Pyrite and Marcasite,' published in full in *Bulletin* No. 186, of the U. S. Geological Survey. The new method here proposed for quantitative determination of these minerals involves many intricate precautions which have been carefully and thoroughly worked out. So that although the process and apparatus seem to call for rather difficult manipulation, the method is likely to be very welcome to every student of this subject. Proper criticism of its details could only be justified by repetition of the process. In the absence of this I am entirely ready to accept its logical results, viz., that in this chemical method we at last possess a satisfactory means for discrimination of the two minerals and for approximate determination—to a degree of accuracy of within 1 to 3 per cent. in Dr. Stokes's skilled hands—of the amount of each in the generally composite specimens of pyrites found in nature.

There are certain inferences, however, which I cannot recognize as proved, in opposition to views advanced many years ago in my paper 'On the Variation of Decomposition in the Iron Pyrites; Its Cause, and Its Relation to Density' (*Annals of N. Y. Acad. Sci.,* Vols. III. and IV., 1887).

1. Dr. Stokes maintains 'that the hypothesis that most specimens of pyrite and marcasite, even when well crystallized, are mixtures of the two, or paramorphs, is without foundation.' Of the truth of that hypothesis, I think, much confirmation is found in the results obtained by this chemical method. In my paper (*loc. cit.,* pp. 179–180) it was pointed out for the first time 'that, on a fresh fracture, unaffected by alteration, the true color of marcasite is invariably *grayish white, nearly tin-white';* while 'normal pyrite has a pale brass-yellow color' (p. 213). These color characteristics of the normal native minerals are accepted by Dr. Stokes, but further assumed by him as criteria for discrimination of the *pure* minerals, the very problem under investigation. Thus, in the determination of the oxidation-coefficient, *p,* five samples of pyrite and nine of marcasite were selected 'as being free from visible impurity and showing characteristic crystallization.' These fourteen samples served as the standards on which all following determinations of this coefficient have been based; apparently the same criteria were assumed in selection of the samples ground up for mixtures, in application of the process to calculation of the curve. But the visibility of impurities may have little value in their recognition, above all when the admixture becomes molecular. Even those samples, at the one extreme, selected for purity and mostly for perfection of crystallization, have revealed to Dr. Stokes, in the variations of *p,* the intermixture of one or of the other mineral, as well as of other impurities, in notable amount. At the other extreme (page 36 of his paper), out of 13 miscellaneous

specimens, six (Nos. 16, 19, 20, 22, 23 and 25) display paramorphic constitution, the amount of marcasite varying from 3 to 74 per cent.; this, too, notwithstanding that the intermixture is invisible, and that it presents the color and sometimes the crystalline form of one or the other mineral. The possibility of purity in some samples of pyrite had been shown in 12 specimens of my paper (page 204) and is confirmed by 5 out of 6 in another series of Dr. Stokes's (page 39); but even there the existence of paramorphism is proved by the last, No. 33, which, with at least the white color of marcasite, is found by Dr. Stokes to contain 83 per cent. of pyrite. Abundant evidence appears in both papers to prove the variation in intermixture in specimens of both minerals; the visibility of the impurity, when in the form of mechanical intermixture, as granules, films, etc.; and its invisibility when present, even in large amount, in molecular diffusion.

2. It is Dr. Stokes's view 'that the density affords no criterion of the composition,' in opposition to my statement that 'the latent constitution of these composite minerals is indicated by variation in density, exactly proportionate in most cases to the amount of each constituent.'

aside from the influence of their unquestionable intermixture. With the new evidence from Dr. Stokes's experiments, I am the more inclined to believe, at least, that these variations in density are caused by so many and such irregular conditions that they may not afford us reliable evidence as to the proportion of one, the marcasite impurity, in those specimens whose unusually low density, below 4.88, may indicate the influence of enclosures, cavities or abnormal composition. But the table of Dr. Stokes (page 39) has no bearing on this conclusion, since in specimen No. 28 the composition was not deduced from density, but, as in two others, from the abundant tarnish (page 204 of my paper), and Nos. 29 to 32 from abnormally low densities, 4.856 to 4.791; these were below that of marcasite, 4.88, as shown by Dr. Stokes, and therefore plainly due to enclosures of quartz, etc. The same objection disposes of the relevancy of the last four numbers in his table on page 13. All that is of present interest to science is the question whether there is any close relation between the true densities of the two minerals and those of their native specimens. Taking, then, from his tables all the specimens of both minerals of known densities which lie between these datum-points, and for which Dr. Stokes has ascertained the constitution by his chemical method, the following table presents the entire information on the subject now available. In the last column I have added the proportion of marcasite founded on density.

Nos.	Mineral.	Locality.	Density.	Marcasite Percentage.	
				Stokes.	Julien.
2	Pyrite.....	Col., Conn. and Utah.....	5.018		
3			5.023	0	0
5			5.041		-
6	Marcasite....	Dover Cliffs, Eng.....	4.881	100	99.5
7	" "	Galena, Ill.....	4.891	100	92.2
9	" "	Linden Mine, Wis.....	4.901	100	84.9
10	" "	Galena, Ill.....	4.886	100	95.8
11	" "	Hazel Green, Wis.....	4.896	100	88.5
12	" "	Weardale, Eng.....	4.880	100	100
14	" "	Webb City, Mo.....	4.887	100	95.1
23	" "	Crow Branch Mine, Wis.....	4.891	74	92.2
28	Pyrite.....	Galena, Ill.....	5.015	0	0
33	Marcasite....	Cumberland, Eng.....	4.987	17	23.3

Further study of etched surfaces, described in my paper, had already led me, during the fourteen years since its publication, to recognize other conditions of structure and of composition which affect the density of pyrites,

For this purpose, accepting Dr. Stokes's determination of the density of marcasite at 4.88, the formula given in my paper (page 178) would assume the form

$$x = \frac{17496}{a} - 3485,$$

in which x represents the percentage proportion of marcasite in the specimen under trial, and a the specific gravity of the specimen.

So far as these specimens go, there appears a fair approximation between the results of the chemical method and those founded on density, except in three cases (Nos. 9, 11 and 23), all from lead-mines in Wisconsin, in which Dr. Stokes detected the common enclosure of galenite, etc. Obviously the above series is not well chosen to afford a certain decision either way; only a series of crystallized specimens, with densities lying *between* the datum-points, 5.02 and 4.88, could be of service for satisfactory comparison. Therefore it appears to me that this second inference of Dr. Stokes also remains unproved.

The main object of my own paper in 1887, however, was the establishment of a principle of practical bearing and importance, in reference to roofing slate, coal and building-stone. This was the connection of the stability of the pyrites, whether marcasite or pyrite, in resistance to atmospheric agencies of decomposition, with the higher densities of these minerals, *i. e.*, in their ordinary forms of distribution in nature, apart from association with other sulphide-ores. It was there stated (page 222) that 'the highest stability can be expected only from samples of crystallized marcasite or pyrite whose specific gravity exceeds 4.99 * * * though little danger from decomposition may be expected down to a specific gravity 4.97.' This subject has not been considered in the paper of Dr. Stokes, has no necessary dependence on either of the purely hypothetical views already discussed, and the above conclusion, I believe, so far remains unquestioned.

Alexis A. Julien.

Columbia University.

COILED BASKETRY.

To the Editor of Science: May I say that no coiled basketry of any kind was made by the Indians of North America east of the Rocky Mountains? In the books there does not seem to be one illustration of coiled work taken from the surface of ancient pottery in this area. I am aware that in the Appalachians, and especially among the Cherokees, there is a kind of bread tray made of straw and sewed with wooden splints, after the old-fashioned beehive, but I am not positive that these are of pre-Columbian origin; second, that a little coiled work was done by the Comanches, but they are Shoshonean, and belong west of the Rockies; third, that the Mackenzie River hunting bags of babiche are coiled, but the makers are Athabascan; fourth, that the Central Eskimo make poor trinket baskets in coiled work which look dreadfully modern. With these facts in mind I am not prepared to say, without the permission of my colleagues, that the ancient tribes east of the Rocky mountains knew anything in the world about coiled basketry.

O. T. Mason.

THE MUD SHOWER.

Noticing in Science of May 2, p. 718, an account of a 'mud shower' at Easton, Pa., on April 12, by J. W. Moore, I wish to record the fact that a similar shower was observed at New Haven, Conn., on the same day, but between 4 and 5 P.M., instead of noon. White clothes hanging on lines in the yards were spotted in a very annoying way, every drop of rain leaving a mud-colored spot. The same kind of spots appeared on the window glass of houses. Ladies who attended the ball game that afternoon had their clothes badly spotted, showing that the shower here covered a considerable area, for the game was played on grounds in the suburbs. The shower was a slight one, of short duration, but every separate drop seemed to be charged with dirt. There had been showers of clean rain on the previous day. Is it not possible that the dirt was cosmic dust or of meteoric origin?

A. E. Verrill.

MAGNETIC DISTURBANCE AT TIME OF ERUPTION OF MONT PELÉE.*

COINCIDENT, as far as can be at present ascertained, with the time of eruption of Mont Pelée on May 8, a magnetic disturbance set in which was registered on the self-recording instruments of the two U. S. Coast and Geodetic Survey magnetic observatories, the one at Cheltenham, Md., seventeen miles southeast of Washington, and the other at Baldwin, Kansas, seventeen miles south of Lawrence. The preliminary reports received from Mr. L. G. Schultz, in charge of Cheltenham observatory and Mr. W. C. Bauer, in charge of Baldwin Observatory are sufficient to indicate that the disturbance began at practically the same instant of time at both observatories, viz., at 7h. 54m. St. Pierre local mean time. According to the newspaper reports the catastrophe befell St. Pierre about 8 A.M. of May 8 and it has been stated that the town clock was found stopped at 7h. 50m.

Purely mechanical vibrations caused by earthquakes are often recorded by the delicately suspended magnetic needles, as for instance the Guatemalan one which was felt at the Cheltenham Observatory on April 18 from about 9h. 20m. to 9h. 50m. P.M., 75th meridian mean time.

The disturbance on May 8, however, was distinctively a *magnetic* and not a seismic one and hence was not recorded on seismographs. The Cheltenham magnetograms exhibit magnetic disturbances amounting at times to .00050 to 0.00060 c. g. s. units (about 1/350 of the value of the horizontal intensity) and from 10′ to 15′ in declination, beginning at the time stated and continuing until midnight of the 9th. Even on the 10th tremors were still discernible. (At the time of writing the subsequent curves had not yet been received.)

Until further information has been received from other observatories, it cannot be determined definitely whether this magnetic disturbance was due to some cosmic cause or came from within the earth's crust and was associated with the Martinique eruption. The coincidence in time is however a remarkable fact.

L. A. BAUER.

U. S. COAST AND GEODETIC SURVEY,
May 17, 1902.

* Communicated by permission of Superintendent O. H. Tittmann, Coast and Geodetic Survey.

THE GUATEMALA EARTHQUAKE WAVES OBSERVED IN CANADA BY R. F. STUPART.

TO THE EDITOR OF SCIENCE: By permission of Professor R. F. Stupart, Director of the Meteorological Service of Canada, I send you herewith seismograms (Milne system) of April 18, local reckoning, recorded at Victoria, B. C., and Toronto, Canada; also a print of the magnetogram (bifilar trace) at Agincourt, nine miles from Toronto.

Each of these records the earth billows emanating from the region of the recent earthquake in Guatemala. Professor Stupart states

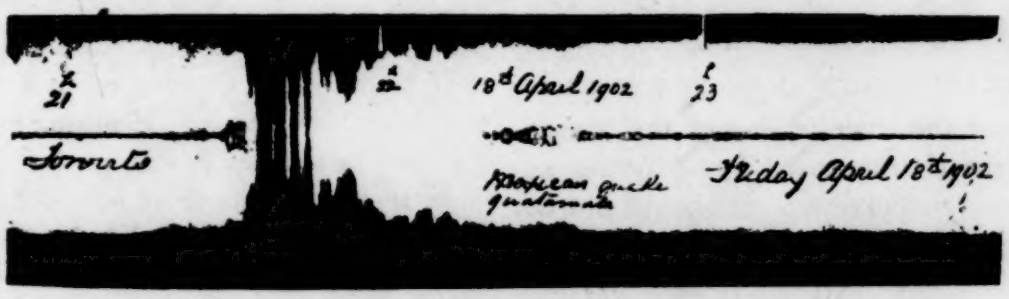

FIG. 1. Record of Milne Seismograph, Toronto, April 18, 1902.

that "the preliminary tremors began at Toronto 2 h. 30.5 m. A.M., April 19 of Greenwich mean time, and at Victoria 2 h. 31.3 m., G. m. t. Large waves began at Toronto 2 h. 35.5 m., but at Victoria 2 h. 37.2 m. The maximum wave occurred at Toronto 2 h. 38.0 m., but at Victoria 2 h. 50.7 m. The end occurred at Toronto 5 h. 24.0 m., but at Victoria about 5 h. 36.4 m. The amplitude at Toronto was over 25 mm.

"In the magnetic observatory at Agincourt, nine miles from Toronto, the bifilar magnet began to swing at 2 h. 35.0 m., Greenwich mean time, and was at its maximum swing at 2 h. 44.4 m. Facsimiles of the records at Toronto, Victoria and Agincourt are given in the accompanying figures, Nos. 1, 2, 3, respectively."

C. A.

WASHINGTON,
May 7, 1902.

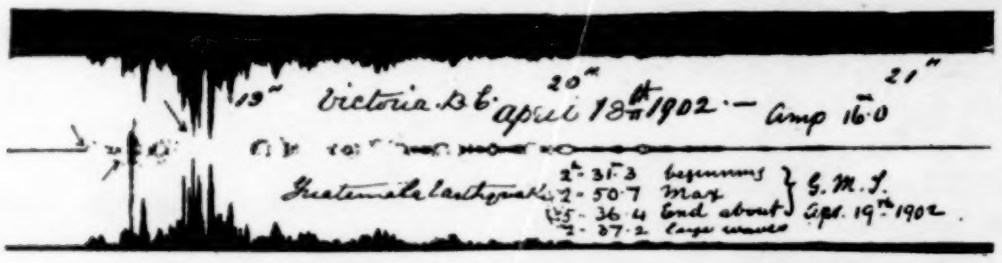

FIG. 2. Record of Milne Seismograph, Victoria, April 18, 1902.

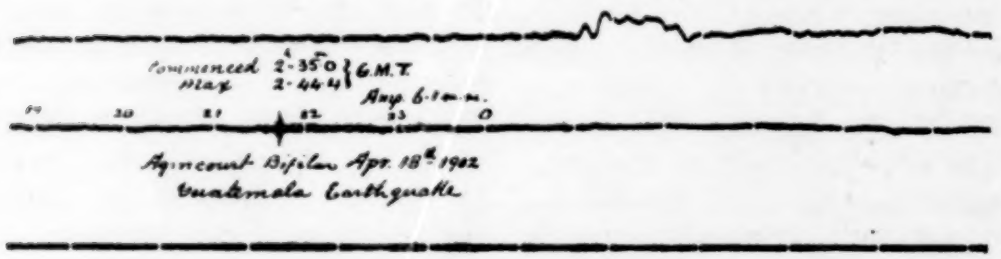

FIG. 3. Record of the Bifilar and other Magnets, Agincourt, April 18, 1902.

SHORTER ARTICLES.

INTRACELLULAR CANALICULI OF THE LIVER.

THE cells of the liver in one of the higher vertebrates are characterized by activities at once numerous and diverse. It should not be surprising therefore if a specialized mode of communication were found between the hepatic cells and the blood capillaries with which they are related. Such a connection has, in fact, been predicted.

In a series of studies published from Cracow, Browicz has indicated grounds for believing that minute channels exist in the cells of the liver, and that these are continuations of the vascular system. More recently, Schaefer* has noted the presence of such canaliculi in specimens injected in the laboratory of the late Professor Rutherford, of Edinburgh.

Some time ago the writer was at work on the vascular supply of the chief organs of vertebrates. In the course of these studies, many, probably fifty, injections were made with gelatine-carmine, well acidulated, of the livers of the rabbit, rat, cat and other mammals. The injection was made through the portal vein in every instance. The most painstaking precautions were always taken to secure the conditions which experience had shown to be necessary for proper injection, and some of the results were as nearly perfect as could be.

In sections made from successfully injected livers, the network of lobular capillaries is uniformly filled, there is no indication of extravasation, and the hepatic cells show no sign of distortion. In such specimens, exceedingly tenuous canaliculi may be seen within the cells, filled with the red injecting-mass, branching more or less, and anastomosing with each other. Under a high magnification, the blood capillaries do not present perfectly smooth walls, but exhibit minute, spine-like elevations at intervals. The connection between the intracellular canaliculi and the outpushings of the capillary wall may occa-

* Schaefer, E. A., *Anatomischer Anzeiger*, 1902, Bd. 21, S. 18–20.

sionally be seen with unmistakable definiteness. In fact, there can be hardly a doubt that the canaliculi constitute a series of fine twigs of the vascular system ramifying into the cytoplasm of the liver cells.

With such a direct relationship traceable between the interior of the cell and the stream of blood passing through the liver, it appears evident that the intracellular canaliculi noted must come to occupy a not unimportant place in our conceptions of hepatic functions. My only explanation as to why these structures have not been recorded before lies in the fact that injected material is usually examined only with low powers of the microscope.

GILBERT L. HOUSER.

LABORATORY OF ANIMAL MORPHOLOGY,
UNIVERSITY OF IOWA.

THE NICHOLS RESEARCH MEDAL OF THE AMERICAN CHEMICAL SOCIETY.

AT the first meeting of the New York Section of the American Chemical Society during the present session, the Secretary, Dr. J. A. Mathews, announced upon behalf of the executive committee that it was its intention to award a medal for chemical research, and to secure the necessary funds for the endowment of that medal in perpetuity and to raise a research fund from which grants might be made for the encouragement of scientific work. The executive committee became personally responsible for the award of the medal for the present year, and a committee on research fund and medal, with Dr. Maximilian Toch, chairman, was appointed. As the result of this movement, Professor Marston T. Bogert announced to the New York Section at its May meeting that Mr. William H. Nichols had conveyed to the American Chemical Society in trust for the New York Section, securities to the value of over $1,000 for the endowment of a medal to be given annually to the author of the best paper embodying original chemical research presented before the Section and subsequently published in the *Journal of the American Chemical Society*. It is not intended to limit this award to members either of the Section or of the Society at large, but to open the competition to all scientists.

Mr. William H. Nichols is a charter member of the American Chemical Society and is president of the General Chemical Company. In expressing its gratitude to Mr. Nichols the Section asked of him the honor of naming the medal 'The Nichols Medal of the New York Section.' Mr. Nichols, in acceding to this request, said that he did so in the hope that others would be induced to do likewise. Dr. Toch stated that other members and friends of the Section had contributed nearly enough to provide for the securing of an artistic design and die for this medal, for the annual presentation of which Mr. Nichols' generosity has provided.

*METEOROLOGY IN ARGENTINA.**

IT is well known that our countryman, Dr. B. A. Gould, of Cambridge, Mass., after having established an astronomical observatory in Argentina, turned his attention to climatology and inaugurated a meteorological office under the general directorship of Mr. Walter G. Davis, who had accompanied him from this country. After publishing about twenty annual volumes of meteorological observations and climatological investigations, Mr. Davis has now succeeded in realizing the great step in meteorology that has been taken by nearly every other climatological bureau. He has namely organized in Buenos Ayres, under the Argentine Department of Agriculture, a branch office that publishes a daily weather map based on telegrams from all available points. A recent letter from Mr. Davis states that "since the beginning of this year, I have had my time fully occupied in getting the daily weather may service organized; it is now fairly started, but far from being complete. We have free use of the national telegraph lines—as well as of nearly all the private railway wires—for the transmission of the 2 P.M. observations. At present there are nearly 70 stations sending in complete observations, and 350 pluviometric stations. Within the next few months I hope to have about 130 second class stations and a large increase in the rain-

* Prepared for the June number of the *Monthly Weather Review*.

reporting stations. The observations are sent here (Buenos Ayres) and the maps printed in our own establishment. The recent extension of the telegraph lines to the southern territories has been a great boon to us from a meteorological point of view; the coast line is now at Rio Gallegos in Santa Cruz, and another branch is being constructed near the foot of the Cordilleras from latitude 38 to 47 degrees south and then crosses the country to the Atlantic coast. This is a most important line for us, as it will give us communication with the region where nearly all the 'pamperos' have their birth and development.

"No attempt has been made at forecasting, as I consider it better to have some experience with the conditions, as shown by the daily maps before undertaking to do too much; I trust however that his branch of work will come in due time."

The daily map published by the meteorological office at Buenos Ayres makes a very imposing appearance. It is 16.2 inches high by 11.1 broad and extends between the 46th and 77th degree of longitude west from Greenwich and between the 21st and 57th degree of south latitude. This region, in the Southern Hemisphere, corresponds to a portion of the Northern Hemisphere, extending north and south, between Turks Island, Bahamas, and Maine, Labrador, and east and west between Washington, D. C., and Cape Farewell. When this large region in the Southern Hemisphere shall have had its storms and 'pamperos,' its isobars and isotherms thoroughly studied, we shall feel that a great advance has been made in the meteorology of the globe.

We are not informed whether the daily weather map of the Province of Buenos Ayres, published for ten years past by the Observatory at La Plata, will be discontinued—but evidently the much more comprehensive work of the general Department of Agriculture must supersede that.

The elaborate presentation of Argentine climatology, compiled by Dr. Davis for the official volume of statistics of that Republic is about to appear in Spanish and English text, as a special treatise by him, on the climate of that region. The climatology of Dr. Davis and his new daily weather map show that the meteorology of the South Temperate Zone of America is in excellent hands.

SCIENTIFIC NOTES AND NEWS.

The retirement of Surgeon-General Sternberg will be made the occasion of a dinner to be given in New York City on June 13. Those wishing to express their appreciation of Dr. Sternberg's great services to the army, to the medical profession and to science by attending the dinner should address Dr. Hermann H. Biggs, 5 West 58th Street, New York City.

Dr. Roswell Park, director of the State Pathological Laboratory at Buffalo, will give the annual address before the Medical School of Yale University at the approaching commencement.

The Geological Society of London has elected as foreign correspondents Professor T. C. Chamberlin, of the University of Chicago; Professor S. W. Williston, just called to the University of Chicago, and Dr. T. Thoroddsen, of Iceland.

The Linnean Society of London has elected as foreign members Professors C. S. Sargent, F. E. Schultze, J. Wiesner, H. J. Hansen and A. Giard.

The Liverpool Biological Society gave a complimentary dinner to Professor W. A. Herdman on the occasion of his return from investigating the pearl oyster fisheries of Ceylon.

M. T. Moureaux succeeds the late M. Renou as director of the magnetic observatory in the Parc Saint-Maur.

The Rede lecture at Cambridge University will this year be given by Professor Osborne Reynolds, F.R.S., his subject being 'On an Inversion of Ideas of the Structure of the Universe.'

Dr. Thomas L. Watson, of Denison University, will continue field work during the coming season on the manganese and ochre deposits of Georgia, for the Geological Survey of Georgia.

DR. HERM. JORDAN, formerly assistant in the Zoological Station, Naples, has gone to Zurich as assistant in the Concilium Bibliographicum.

PROFESSOR JOHN H. KINEALY, head of the department of mechanical engineering at Washington University, in St. Louis, has resigned to engage in private practice.

DR. S. W. WILLISTON, whose call to the chair of paleontology in the University of Chicago we announced last week, will also have charge of the paleontological collections in the Field Columbian Museum.

THE Council of the Geological Society of America has recommended candidates for election as fellows: Frank M. Anderson, B.A. (Stanford, '95), M.S. (Univ. of Cal., '97), Berkeley, Cal.; Ernest Robertson Buckley, B.S., Ph.D. (Univ. of Wis., '98), Rolla, Mo., state geologist and director of Bureau of Geology and Mines; Arthur J. Collier, A.B., A.M. (Univ. of Oregon), S.B. (Harvard), Washington, D. C., assistant geologist U. S. Geological Survey; John Burchmore Harrison, M.A. (Cambridge, England), F.I.C., F.G.S., Georgetown, Demerara, Brit. Guiana, government geologist; Edward Henry Kraus, B.S., M.S. (Syracuse, '97), Ph.D. (Munich, '01), Syracuse, N. Y., associate professor of mineralogy, Syracuse University; George Davis Louderback, A.B., Ph.D. (Univ. of Calif., '96 and '99), Reno, Nev., professor of geology, University of Nevada; George Curtis Martin, B.S. (Cornell), Ph.D. (Johns Hopkins), Baltimore, Md., assistant in paleontology, Johns Hopkins University, has been assistant geologist on the Maryland Geological Survey; Walter Curran Mendenhall, B.S. (Ohio Normal Univ.), Washington, D. C., geologist, U. S. Geological Survey; George Henry Perkins, A.B., Ph.D. (Yale, '67–'69), Burlington, Vt., professor of geology, University of Vermont, state geologist; William Sidney Tangier Smith, B.L., Ph.D. (Univ. of Calif., '90–'96), Washington, D. C., assistant geologist, U. S. Geological Survey; Alfred William Gunning Wilson, A.B. (Toronto), A.M., Ph.D. (Harvard, '01), Cobourg, Ontario, Can., geologist, temporary staff, Geological Survey of Canada.

DR. JOHN ALEXANDER MATHEWS, of Columbia University, has been informed by the secretary of the Iron and Steel Institute of Great Britain that 'by the unanimous vote of the president and council the first Andrew Carnegie Gold Medal for research' had been awarded to him on May 8. Dr. Mathews has held the university fellowship in chemistry and has three times been awarded the Barnard fellowship for the encouragement of scientific research, both by Columbia University A year ago the Carnegie research scholarships of the Iron and Steel Institute were awarded to Dr. A. Stansfield, of London; Mr. Julius Goldberg, an Austrian; and to Dr. Mathews. At the meeting of the Institute held in London, May 7 and 8, his paper entitled, 'A Comparative Study of Some Low Carbon Steel Alloys,' was presented and for it the medal was awarded. Mr. Carnegie was so well pleased with the result of his original endowment that he has doubled his gift for next year with the result that six research scholarships have been awarded for the coming year. Three of these were awarded to English metallurgists, one to a Parisian, one to a resident of Berlin and the sixth to Mr. William Campbell, an Englishman, who is at present studying with Professor H. M. Howe. Mr. Campbell is an 1851 exhibition scholar and fellow-elect in metallurgy at Columbia University. Mr. Campbell and Dr. Mathews worked together with Professor Sir William Roberts-Austen and later with Professor Howe, and Mr. Campbell's appointment to the Carnegie scholarship is made with the understanding that he continue researches upon low carbon steel alloys.

THE centenary of the birth of the Norwegian mathematician, Niels Henrik Abel, will be celebrated at Christiania in September. Abel was born in 1802 and died at the early age of twenty-seven years, but in this short period attained rank among the foremost mathematicians of the century.

MR. JEFFERSON CHASE, the well-known inventor, died in Portland, Me., on May 20. Mr. Chase, his father, brother and son, made many inventions, including a circular saw, a water wheel, wood pulp pails, etc.

Mr. C. Henry Wernle, a maker of mathematical instruments at the U. S. Arsenal at Frankfort, died on May 20, aged seventy-one years.

Mr. George Griffith, the assistant general secretary of the British Association for the Advancement of Science, and formerly science master of Harrow School, died on May 7, at the age of sixty-eight. Mr. Griffith had been connected with the British Association for over forty years, having first acted as local secretary in 1859 for the Oxford meeting. An English correspondent writes: "Mr. Griffith's death will be keenly regretted by the members of the Association, with whom his relations were most courteous, he being, as is needful in that position, one of those who 'suffer fools gladly.' His death was unexpected. He died in harness."

Dr. G. Monro Grant, since 1887 principal of Queen's College, Kingston, a well-known Canadian educator and author, died on May 11, at the age of sixty-seven years.

The fourteenth annual meeting of the Association of Economic Entomologists will be held in Pittsburgh, Pa., on Friday and Saturday, June 27 and 28. Sessions will be held in the west room of Carnegie Lecture Hall, Carnegie Institute, Schenley Park. The opening session will convene on Friday at 10:00 o'clock A.M. Members are requested to send titles of communications, which they may desire to present, as soon as possible to the secretary, Professor A. L. Quaintance, College Park, Md.

The Royal Society of Canada is this week holding its annual meeting at Toronto, the exercises being on May 27, 28 and 29. They include the address by the president, Dr. James Loudon, president of the University of Toronto and professor of physics, whose subject is 'Universities in Relation to Research,' and a popular science lecture by Dr. Jeffrey, of the University of Toronto, on 'The Forest Trees of Canada.' The Society meets in four sections, one devoted to French literature, one to English literature, one to the mathematical, physical and chemical sciences and one to the geological and biological sciences.

In connection with the proposal to enlarge the Royal Society so as to include representatives of the historical, philological and moral sciences, or to establish a new academy for these sciences, Mr. Charles Waldstein, of King's College, Cambridge, has proposed the establishment of an Imperial British Academy of Arts and Sciences, which would include four sections as follows: The Royal Society for the natural and mathematical sciences, a new Royal Society of Humanities for the historical, philological and moral sciences, the present Royal Academy for painting, sculpture, architecture and the decorative arts, and a new Royal Academy of literature and music.

We have noted that a commission is considering the question as to whether a state electrical laboratory should be established in New York state, to provide means for testing electric measuring instruments. Of this proposal the *Electrical World and Engineer* says: "We sincerely hope that no such state laboratory will be established, as it would be worse than useless expense. The Bureau of Standards at Washington is a national body, charged with doing this precise work among other duties. There is no immediate likelihood of this bureau being so far overwhelmed with electrical work as to be incapable of supplying the demand. No sub-standardizing bureaus should be called into official existence without being annexed to the National Bureau at Washington. A number of state electric standardizing bureaus are likely to lead to just as many different values of the volt, ampere and watt, besides involving much reduplicated labor and expense. Were the states generally to indulge in the practice, the situation might become particularly unbearable to the manufacturing companies doing business all over the country."

The botanical laboratories, presented to University College, Liverpool, by Mr. W. P. Hartley, were opened by Sir William Thiselton-Dyer, F.R.S., on May 10 last.

Before the Zoological Society of London on May 6 Mr. Oldfield Thomas, F.R.S., read a paper on the 'Mammals obtained during the

Whitaker Expedition to Tripoli. At Mr. J. I. S. Whitaker's expense Mr. E. Dodson had made a successful collecting expedition into Tripoli, and the specimens of mammals obtained had been presented to the National Museum. Twenty-one species were referred to, and, among others, a Hare (*Lepus whitakeri*), allied to *L. æthiopicus,* but of a bright pinkish buffy color, and a Gundi (*Ctenodactylus vali*) like *C. gundi,* but with much larger bullæ, were described as new.

WE learn from *Nature* that a meeting of delegates representing a number of natural history and photographic societies was held at Croydon on Friday, May 9, Mr. W. W. Whitaker, F.R.S., being in the chair, to consider and set in motion a photographic survey of Surrey. It was resolved that a society be formed to be called 'The Photographic Survey of Surrey,' and that its object be to preserve a record in permanent photographs of buildings of interest, antiquities, scenery, geology, natural history, anthropology, and of portraits of notable persons, representations of passing events of local or historical importance, and of old records, rare books, prints, maps, so as to give a comprehensive survey of what is valuable and representative in the county of Surrey.

AT a meeting at the Mansion-house on May 18 the Duke of Devonshire, as reported in the *Times,* spoke as follows concerning the conditions which have to be complied with before incorporation of University College with the University of London can take place: The value of the site, buildings, and equipment to be transferred under the scheme provisionally settled between the authorities of the college and the senate of the university is estimated at £500,000, and in addition the administration of the income of certain trust funds, which amount to nearly £300,000, will pass to the university. In order to make the transfer effectual certain preliminary conditions were required: (1) The extinction of the debt upon the college, which has been accomplished by a gift of £30,000 from the Drapers' Company. (2) The removal of the University College School, an institution of a secondary type, in order to obtain the needful accommodation for university teaching and research, the cost of which is estimated at £60,000. (3) An arrangement by which separate provision, including class-rooms, laboratories, and a pathological museum, can be made for advanced medical studies in order to place the school of medicine on a proper footing, which is calculated to cost another £40,000. Towards this sum of £100,000, which is the immediate object of the appeal, £30,000 have been given by an anonymous donor, and there are other sums promised to the extent of £15,000. On the remaining £55,000 being raised and the college placed at the disposal of the university, the £20,000 offered by Mr. Astor for the increase of the endowment of chairs becomes immediately available for university purposes, and the university will also assume direct administration of that part of the contribution of the Technical Education Board which it has hitherto entrusted to the college. Later and at far greater cost, as the funds at the disposal of the university increase, it is hoped that further advantage will be taken of the opportunities presented by the acquisition of the college for the development of higher education. Schemes for the completion of the west wing, to include the space required for engineering, applied mathematics, physiology and chemistry, are in contemplation, and other changes that would give sufficient accommodation to the departments of zoology, anatomy and physics and also provide a library of adequate dimensions. For the present, however, two great objects will be gained by the success of the appeal for £100,000: (1) A fuller utilization of the resources of the college as an establishment for the promotion of advanced studies; and (2) the provision for the university, which has as yet done little but create administrative machinery, of the means of entering fairly well equipped upon the twofold mission of instruction and research.

UNIVERSITY AND EDUCATIONAL NEWS.

MR. ISAAC H. CLOTHIER, of Philadelphia, has offered $100,000 to Swarthmore College on condition that an endowment fund of $600,000 be

collected. It is reported that the further sum of $250,000 has been subscribed.

Wesleyan University has received an anonymous gift of $75,000 for the erection of a new science building.

In addition to the gift of $50,000 from Mr. D. O. Mills, noted last week, the University of California has received about $20,000 for the purchase of books from Mrs. Phoebe Hearst, Mrs. Jane K. Sather and Mr. Claus Spreckels; $5,000 for a lectureship in the College of Commerce from Mr. Henry Weinstock, and $8,000 for a chair in physiology from Dr. M. Herzstein.

The Secretary of the Navy was authorized in 1900 to complete plans for new buildings and improvements for the Naval Academy at Annapolis at an expense not exceeding $8,000,000. We learn from the report of the House Committee on Naval Affairs that the armory and the boat-house are nearly finished and the foundations of the marine engineering building are being constructed, the expenditure so far amounting to nearly $1,200,000. The contract has been let for the cadets' quarters, which will cost $2,248,000, accommodating 1,200 cadets. The gymnasium and officers' quarters will be under contract by June 1, as will also be the building known as the officers' mess, and plans for the sea-wall work are now practically completed and will be advertised in a short time.

Miss Margaret F. Washburn, Ph.D. (Cornell), has been elected to the professorship of psychology in the University of Cincinnati vacant by the removal of Professor Judd to Yale University. Miss Washburn is at present warden of the women's college at Cornell University and will occupy a similar position at Cincinnati.

Dr. Arthur Lachman has resigned the chair of chemistry and the deanship of the College of Science and Engineering in the University of Oregon.

Dr. John H. Washburn has resigned the presidency of the Rhode Island College of Agriculture and the Mechanic Arts at Kingston.

Professor David Franklin Houston, professor of political science in the University of Texas, has been elected president of the Texas Agricultural and Mechanical College at Bryan.

The board of governors of McGill University has appointed Dr. Wyatt Johnson, assistant professor of hygiene, to be professor of hygiene, in succession to Dr. Craik. The following appointments of demonstrators have also been made: Alfred W. G. Wilson, Ph.D., in geology; Mr. Howells Frechette, B.Sc., in metallurgy; Mr. K. M. Cameron, B.Sc., in civil engineering; Mr. H. A. Burson, M.Sc., and Mr. E. L. Franklin, B.Sc., in electrical engineering.

Appointments at Yale University have been made as follows: L. F. Rettiger, to be instructor in bacteriology; Andrew L. Winter, instructor in organic analysis; and Arthur L. Dean, assistant in plant physiology.

Dr. William B. Huff, now assistant in physics at Johns Hopkins University, has been appointed associate in physics at Bryn Mawr College.

H. L. Rietz, assistant in mathematics at Cornell University, has been appointed to fill the chair of mathematics at Butler College.

The following appointments have been announced at Cornell University: E. J. McCaustland, assistant professor in civil engineering; Herman Diedrichs, assistant professor in experimental engineering; Dr. Ernest Albee and Dr. Albert Lefevre, assistant professors in philosophy, and Dr. I. M. Bentley, assistant professor in psychology. In the department of Professor Wilder, Mr. Hugh D. Reed has been promoted from assistant to instructor in systematic and economic vertebrate zoology, and the graduate scholarship in neurology has been for the second time assigned to Mr. Thomas L. Hankinson.

Professor H. S. Pratt, of Haverford College, formerly a student in the Zoological Laboratory of Harvard University, is to be abroad next year on leave of absence. His place is to be filled during his absence by R. M. Strong, Ph.D. (Harvard University, 1901).